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### ORIGINAL ARTICLES



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# EDITORIAL

This, the first number of " Agriculture and Live-stock in India ", inaugurates the new series of publications in agricultural and veterinary science, issued by the Imperial Council of Agricultural Research, which will take the place of the " Agricultural Journal of India ", the " Journal of the Central Bureau for Animal Husbandry and Dairying " and the Memoirs and Bulletins of the Imperial Department of Agriculture in India. " Agriculture and Live-stock in India " is intended to be a general journal appealing to a wide circle of readers. The other two journals, *viz.*, the " Indian Journal of Agricultural Science " and the " Indian Journal of Veterinary Science and Animal Husbandry " will be scientific journals and will largely take the place of the Bulletins and Memoirs. It may be observed however that from time to time the Council will also bring out special monographs when scientific material is available for publication which requires a special *format* or which for other reasons cannot conveniently be published in either of the journals. The " Indian Journal of Agricultural Science " will appear in February 1931 and thereafter in alternate months; the " Indian Journal of Veterinary Science and Animal Husbandry " will be a quarterly, the first number appearing in March 1931. During 1931 " Agriculture and Live-stock in India " will appear in alternate months, in the same manner as the " Agricultural Journal of India " which it replaces, but it is hoped to issue it monthly in 1932.

A new feature of the journals will be the abstracts sections. These can only be developed gradually but the Research Council has recently organised a system of abstracting and, with the help of collaborators in the various provinces, it is hoped that all important work in agricultural science published in India will be abstracted in one or other of the journals At present much useful technical information is only published in the reports of Agricultural Departments and of experiment stations and farms where it is not easily accessible, whilst some scientific work of considerable interest to agricultural workers is published in journals not readily available. By means of the system of abstracts now being inaugurated, it is hoped to keep agricultural research workers in India more fully in touch with the work which is being done by other investigators in the country.

The " Indian Journal of Agricultural Science " and its counterpart, the " Indian Journal of Veterinary Science and Animal Husbandry ", will also afford a suitable medium for the publication of a class of mate-

rial which has not been suitably provided for in the past, as the Pusa Memoirs were largely limited to accounts of completed work. The new journals will also be open to short notes on the results of minor investigations or other matters of interest which are suitable for a scientific journal.

The first of the series of special monographs will be " The Fungi of India " by Butler and Bisby, a valuable contribution from the Imperial Bureau of Mycology.

Permission has been obtained from the newly established Imperial Agricultural Bureaux to reproduce in our journals certain of their technical communications and certain abstracts which are of general interest.

Attention is invited to the " instructions to authors " contained elsewhere in this number. Only by the full co-operation of all contributors will it be possible for the Council to achieve the programme for the prompter publication of scientific work which it has set before it. Publication work in India has difficulties of its own—mainly those which are caused by distance. If authors will co-operate in the manner proposed in the instructions—especially in ensuring that all manuscript is complete in every detail when first submitted and by returning proofs promptly—these difficulties can be surmounted.

# ORIGINAL ARTICLES

## REPORT ON THE ALL-BURMA TRACTOR TRIALS, 1930.

BY

A. HAYES, A.M.I.MECH.E.,

*Agricultural Engineer, Burma, Mandalay.*

### I. PRELIMINARY ARRANGEMENTS.

WORK was commenced in organizing these trials in September 1929, when the various agents in Rangoon were asked to submit their entries. There was an excellent response and eleven tractors were entered.

In January a suitable site was chosen at a distance of two miles from Mingaladon Cantonment Railway Station in Shwe-hle-gyaung Kwin, this stretch of land having been lent for the purpose by U Tun, B.A. During the same month work was commenced in levelling the land and constructing *kazins* (bunds), and this work continued until the commencement of the trials on April 28th.

Bunds were so made as to make each plot for each trial of exactly equal acreage and of the same shape, the conditions on all plots being as near as possible the same. In order to get trials on both hard-baked land and in slush at the same time, it was necessary to flood ten acres of land by pumping. This land was flooded continuously for a month before the trials commenced.

The comfort of the spectators was catered for by the erection of a large pandal and quarters were erected for the tractor drivers. A rough motor road was constructed from the main Rangoon-Pegu road to the site of the trials, and a bus service was arranged from Mingaladon to the site.

Arrangements were made with the Burma Railways to issue cheap return tickets to all *bonafide* landowners and cultivators at a single fare for the return journey from all stations in Burma.

The Burma Oil Company very kindly gave all the kerosene, petrol, lubricating oil and grease used during the trials free of charge, and they established a distributing depot at the site.

## II. The object of the trials.

The object of the trials was :—

(*a*) To find out which tractor is most suited to the various conditions prevailing on the paddy lands of Burma during the ploughing season.

(*b*) To study the possibilities of tractor cultivation for paddy lands.

(*c*) To get accurate figures as to the cost of ploughing and harrowing with power draught as against cultivation with bullock draught.

(*d*) To give the various cultivators and landowners who are contemplating buying tractors a chance of seeing the various makes at work under exactly the same conditions.

(*e*) To bring tractor cultivation to the notice of landowners and cultivators in general.

## III. The conditions.

The conditions as laid down before the trials commenced were as follows :—

Each tractor agent or manufacturer will be permitted to enter one tractor of each size or design in which he deals.

These machines must be driven and operated by Burmans or Indians domiciled in Burma, and no expert advice will be allowed whilst the trials are in progress.

Each tractor agent or manufacturer will provide his own drivers and ploughmen, and will forward his tractors to the site and return them at his own expense.

The Agricultural Department will advertise the trials throughout Burma, but firms are asked to co-operate in doing this.

The plots will be allotted to the various entrants by means of drawing numbers.

Judging will be carried out by a Board of three Government officials.

In judging the following points will be taken into consideration :—

(*a*) The quality of the work done.

(*b*) Fuel and lubricating oil consumption.

(*c*) Speed of ploughing or harrowing.

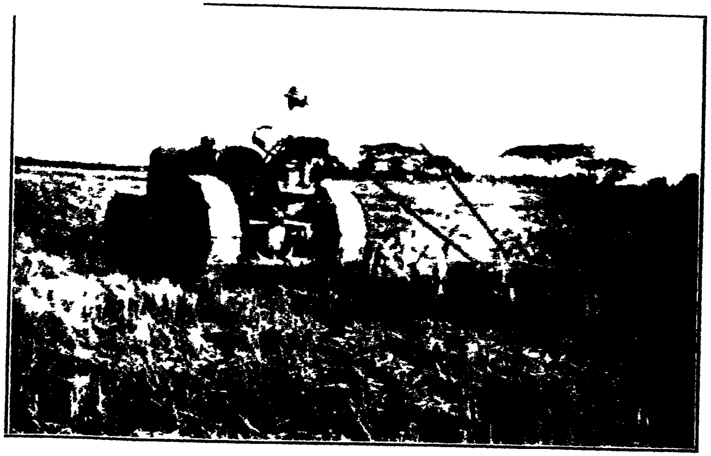
(*d*) Price of the tractor, ploughs and harrows.

(*e*) Draw-bar pull.

(*f*) Accessibility of the engine.

(*g*) General construction of the tractor and its mobility.

In working out the cost per acre ploughed, it will be assumed that the tractor will work for 120 days per annum, each day's work being of 10 hours' duration.


ALL-BURMA TRACTOR TRIALS, 1930.

As it will be impossible to get accurate figures for lubricating oil and grease consumptions in such a limited test, figures will be taken from past records and the cost of the amount used will be given as being the same for each tractor.

The rates for fuel, lubricating oil, and grease, in working out the cost per acre ploughed, will in all cases be the normal Rangoon rates ruling at the time of the trials. These rates are as follows :—

| | |
|---|---|
| B. O. C. Gold Mohur kerosene . . . | Rs. 3-3-0 per 4-gallon tin. |
| B. O. C. petrol . . . . . . | Rs. 2-1-0 per 2-gallon tin naked. |
| B. O. C. tractor lubricating oil . . | Rs. 2-0-0 per gallon naked. |
| B. O. C. Burmoline grease 2 lb. tins at annas seven per lb. | |

## IV. The trials.

The trials were held for three days on April 28th, 29th and 30th, the working hours being from 7-30 A.M. to 10-30 A.M. and from 3-30 P.M. to 5-30 P.M.

### *Trial I.—Monday, April 28th (morning).*

*Ploughing on open, hard-baked, clay soil.*—Each competitor was required to plough three-fourths of an acre to a depth of five inches, this being the usual depth of ploughing on paddy lands in Burma.

Before the commencement of this trial the competitors drew for plots, and the numbers which they drew held good for the remaining trials.

The land was very hard and contained a large percentage of clay.

The drivers, with two exceptions, had had no previous ploughing experience, most of them having been lorry drivers before being taken on for the trials. The ploughing, in spite of this, was, on the whole, good. All the nine tractors competing finished the trial, and there were no compulsory stoppages.

The three International tractors, working on plot Nos. 1, 2 and 9, all did good steady work. The drivers did not rush their tractors and paid careful attention to their ploughing, which was good and even.

The Rushton tractors, working on plot Nos. 3 and 6, did not do so well, due mainly to the inexperience of their drivers. The cost per acre ploughed, in the case of the Crawler tractor, was very high, and the depth of ploughing fluctuated from two inches to ten inches.

The Caterpillar 15, working on plot No. 4, did the best ploughing in the trial at a good steady speed. It made really a good job of the work in hand. It was unfortunate that it was running on petrol only, as this put the working costs up considerably.

The Fordson, working on plot No. 5, did not do good ploughing, and here again the working costs were increased by running on petrol only. The driver of this tractor was apt to lose his head at the slightest provocation.

The two Cletrac tractors, working on plot Nos. 7 and 8, sacrificed the quality of their work for speed. Although the drivers of both machines were good, they had little or no chance of attending to their ploughing at the speed at which they drove. Owing to the drivers finishing their work much more quickly than the drivers of any other tractor, the cost per acre ploughed was less. If a tractor is to have a moderately long life, it is not advisable to drive it, under hard conditions, at full throttle.

The average cost per acre ploughed for all tractors entered was Rs. 5-6-8, and the lowest cost was put up by the 12/20 Cletrac at Rs. 4-2-6 per acre.

Details of the cost per acre ploughed for each machine are given in Appendix I (pp. 10-11), and the marks allotted are given in Appendix V (p. 18).

*Trial II. Monday (evening).*

*Ploughing on half-acre bunded, hard-baked plots.*—Each competitor was required to plough two plots of half an acre each to a depth of five inches, without breaking the bunds.

The three International tractors, working on the same numbered plots, again did good steady work, although the 10/20 and 22/36 tractors could not get into the corners of the small bunded plots, with the result that there was a certain amount of land left unploughed.

One Rushton tractor (four-wheel model) could not start owing to magneto trouble, and the other failed to finish owing to the driver making too sharp a turn and damaging the plough.

The Caterpillar 15 again did the best ploughing. It got into all the corners and left no unploughed land, without in any way damaging the bunds. The ploughing was very straight and even, at a constant depth of five inches.

The driver of the Fordson again lost his head and wandered all over the plots, ploughing at depths ranging from eight to three inches.

The Cletracs did average ploughing but they lost a great number of marks through completely demolishing the centre bund, through turning outside the plots in which they were supposed to be ploughing. Again the tractors were driven too fast to do really good work.

The average cost per acre ploughed for all tractors entered was Rs. 5-5-8, and the cheapest cost was put up by the 12/20 Cletrac at Rs. 4-7-5 per acre.

Details of the cost per acre ploughed for each machine are given in Appendix II (pp. 12-13), and the marks allotted are given in Appendix V (p. 18).

*Trial III. Tuesday, April 29th (morning).*

Each tractor was required to disc-harrow the 1·75 acres of land ploughed on the previous day. As the land was not fit for disc-harrowing immediatly after ploughing, marks were not allotted for the quality of work done, but deductions were made for any land which was missed.

Out of the three International tractors entered, two failed to finish. This was due to the fact that the agents had only one efficient harrow. The 22/36 tractor tried to use a multi-disc wheat-land plough, but as it was not successful it did not complete the plot. The 12/20 tractor was pulling a 24-disc harrow, but as the link broke it was compelled to give up the trial. The Farmall did good work, and, together with the Fordson, was the first to finish.

The Rushton Crawler again failed to finish, and as the agents had only one disc harrow, their other tractor did not compete.

The Caterpillar, Fordson and Cletracs all did good work, and experienced no trouble.

The average cost per acre harrowed for all machines entered was Rs. 1-7-7. The cheapest cost was put up by the International Farmall at Rs. 1-0-2 per acre.

Details of cost are given in Appendix III (pp. 14-15), and the marks allotted are given in Appendix V (p. 18).

*Trial IV. Tuesday (evening).*

Each tractor was to be tested for draw-bar pull with a dynamometer, against a dead load.

Before starting this test strict instructions were given to the tractor drivers to take a steady pull on the dynamometer, but in spite of this the driver of the Cletrac tractor slackened his draw chain, and took a running jerk, with the result that he broke the dynamometer. At this time the draw-bar pull of only two tractors had been tested and as it was impossible to get another dynamometer in Rangoon, the test had to be cancelled.

The 10/20 International tractor had a draw-bar pull of 5,040 lb.

The Rushton (Crawler model) had a draw-bar pull of 5,208 lb.

In place of this test, tractors were tested for ease of manipulation. Careful note was made of the turning radius, ease of crossing bunds, and ease of steering when working on dry and wet lands.

The marks allotted are given in Appendix V (p. 18).

*Trial V. Wednesday, April 30th (morning).*

Each tractor was required to plough a $\frac{3}{4}$-acre bunded plot, having a covering of about six inches of water.

This trial was made more difficult owing to the land being lower at one end of the plot than the other. At the low end there was as much as two feet of water. Considerable delay was caused in getting the tractors into the plot, but the trial eventually started at 8-45 A.M.

The three International tractors did by far and away the best ploughing, and it was noticeable that with angle-iron grouters fitted there was practically no skidding. The work of the Farmall was very good and, taking into consideration the conditions, the cost per acre ploughed, *i.e.*, Rs. 3-3-7, is exceptionally low.

The Rushton 4-wheel model was not entered. The Rushton Crawler performed well, but the driver had no idea of ploughing, and, in addition to missing a great deal of land, the depth varied all over the plot.

The Caterpillar 15 started badly, by first burying its disc plough, and then trying to bury itself. Eventually a mouldboard plough was borrowed and it did moderate work, but due to the tractor having to avoid the buried disc plough about a quarter of the plot was left unploughed. This was unlucky, as, up to this trial, this tractor had done excellent work.

The Fordson sacrificed quality of ploughing for speed, with the result that the driver got the tractor stuck and wasted a good deal of time. The ploughing was uneven and land had been missed at the corners.

The Cletrac tractors both experienced trouble and were continually stopping. The 12/20 was eventually disqualified for detaching the plough in the plot, and trying to plough the land by running the tractor up and down in the slush. In the case of the 20/27 a great deal of land had been missed and no attempt had been made at keeping a straight furrow.

To enable the judges to judge the ploughing, the water was let off the plots on the completion of the test.

The average cost per acre ploughed for all tractors entered was Rs. 4-13-4.

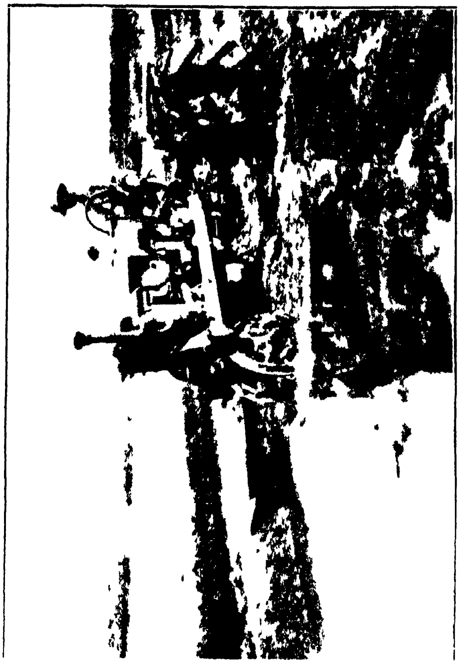
Details of the cost per acre ploughed are given in Appendix IV (pp. 16-17), and the marks allotted are given in Appendix V (p. 18).

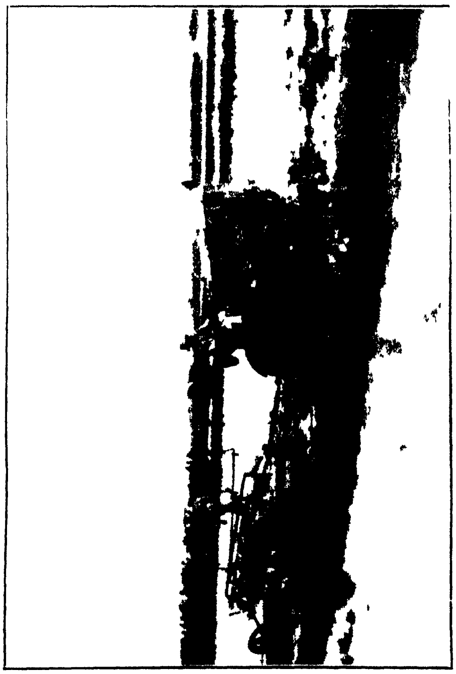
*Trial VI.*

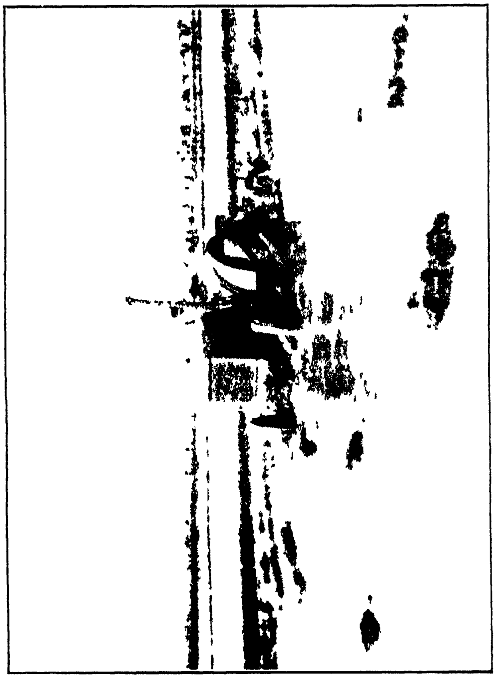
Each tractor was thoroughly inspected and marks were given for general construction and finish.

The 22/36 International has every possible appliance fitted for keeping the fuel consumption down to a minimum. It has removable liners and large inspection

PLATE II.







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doors. It is fitted with a water pump, lubricating oil pump, water by-pass for heating, water injection, adjustable draw-bar, dog clutch pulley, air cleaner, oil filter, double strainer, power take-off and an intake manifold combination.

The 10/20 International is of the same design as the 22/36, except that it has no water pump and no water injection.

The International Farmall is a three-wheel tractor, having the same design of engine as the 22/36 and 10/20 International tractors. It has no water pump, but is fitted with a special combination kerosene petrol carburrettor. It has a 30-inch road clearance with a 8-ft. turning radius.

The 14/28 Rushton Crawler is of very sturdy construction. It has a patent rubber-cushioned crawler which eliminates the jars and makes the tractor run smoothly. It is fitted with adjustable draw-bar, auxiliary gear box, water pump, air filter and dryer, power take-off, sump lubrication, clutch pulley and brake steering.

The Caterpillar 15 caters for the comfort of the driver in that it has a comfortable seat covered by a canopy. It has pump lubrication and the track is fitted with roller bearings. A water pump, lubricating oil pump, air filter, power take-off, inspection doors are all standard fittings. It has an open crawler suitable for taking extension grouters.

The Fordson is a great improvement over the old model. It now has heavy front wheels and is built on the three-section principle. It has splash lubrication and pump cooling. It is fitted with an air filter and fixed pulley. It has no governor, power take-off or inspection doors.

The 14/28 Rushton four-wheel model has the same engine as the Crawler model. It has a governor and a special single throttle control. The wheels are fitted with patent cleats and scrapers to keep them clean.

The 20/27 Cletrac and the 12/20 Cletrac are exactly the same in construction. They are fitted with air filters, oil filters, water pumps, lubricating oil pumps, hand pressure oil feed for crawlers, adjustable governor, and distributor. The crawlers are not of the open type.

Details of the marks allotted are given in Appendix V (p. 18).

## V. Result.

Messrs. Cowie and Co. are awarded the gold medal for the excellent performance of their International tractors.

Messrs. U Po Hlaing & Co. are awarded the silver medal for the good performance of their Cletrac tractors.

Messrs. William Jacks & Co. are awarded the bronze medal for the good performance of their Caterpillar tractor.

# APPENDIX V.

*Table of marks.*

| Tractor | Agent | Test No. 1 | | Test No. 2 | | Test No. 3 Harrowing cost per acre Possible 25 | Test No. 4 Ease of manipulation Possible 10 | Test No. 5 | | Test No. 6 General construction Possible 10 | Test No. 7 General finish Possible 5 | Total Possible 275 | Placing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ploughing Possible 25 | Cost per acre Possible 50 | Ploughing Possible 25 | Cost per acre Possible 50 | | | Ploughing Possible 25 | Cost per acre Possible 50 | | | | |
| 22/36 International. | C. R. Cowie & Co. | 22 | 43 | 15 | 45 | .. | 5 | 20 | 43 | 10 | 4 | 207 | 3rd |
| 10/20 International. | C. R. Cowie & Co. | 20 | 47 | 15 | 40 | .. | 7 | 18 | 47 | 7 | 3 | 204 | 4th |
| 14/28 Rushton (Crawler). | Marshall Cottrell & Co. | 15 | 17 | Not completed. | .. | .. | 8 | 8 | 17 | 9 | 4 | 78 | 8th |
| Caterpillar 15. | William Jacks & Co. | 24 | 31 | 22 | 22 | 20 | 10 | 2 | 30 | 9 | 5 | 175 | 5th Bronze Medal. |
| 12/27 Fordson. | Autocars (Burma), Ltd. | 12 | 35 | 8 | 24 | 19 | 6 | 10 | 29 | 6 | 3 | 152 | 7th |
| 14/28 Rushton. | Marshall Cottrell & Co. | 12 | 37 | Did not enter. | .. | .. | 6 | Did not enter. | .. | 8 | 3 | 66 | 9th |
| 20/27 Cletrac. | U Po Hlaing & Co. | 16 | 49 | 16 | 46 | 20 | 9 | 10 | 40 | 8 | 3 | 217 | 2nd Silver Medal. |
| 12/20 Cletrac. | U Po Hlaing & Co. | 18 | 50 | 14 | 50 | 21 | 9 | Disqualified. | .. | 8 | 3 | 168 | 6th |
| 8/16 Farmall. | C. R. Cowie & Co. | 18 | 45 | 18 | 47 | 25 | 8 | 23 | 50 | 8 | 4 | 246 | 1st Gold Medal. |
| Caterpillar 10. | William Jacks & Co. | | | Did not | compete | | | | Did not | compete | | | |
| International (Crawler). | C. R. Cowie & Co. | | | Did not | compete | | | | Did not | compete | | | |

# THE NECESSITY FOR AUTHORITATIVE DEFINITION OF BREED CHARACTERISTICS AND UNCHANGING CONTROL OF BREEDING POLICY IN INDIA.

BY

COL. A. OLVER, C.B., C.M.G., F.R.C.V.S.,

*Animal Husbandry Expert, Imperial Council of Agricultural Research.*

## PRECISE DEFINITION OF BREED CHARACTERISTICS.

During the past century many attempts have been made to bring about systematic improvement of indigenous Indian cattle, of which numerous more or less distinct breeds are still to be found in a comparatively pure state in certain areas, and various efforts have been made, in comparatively recent years, to define the characteristics of the principal breeds.

Directors of Provincial Veterinary Services in particular have collected much valuable information, which has been published along with accurate measurements and photographs of typical specimens of the particular breeds met with in their own provinces.

Such precise records of breed characteristics are the first step towards any systematic policy of live-stock improvement, and there is no doubt that similar records should be available for all Indian breeds which are considered worthy of retention, until such time as it may be possible to form breed societies and to establish official herd-books.

## EXISTING BREEDS OF INDIAN CATTLE NOT GENETICALLY PURE.

A critical study of the herds maintained at Government farms, and of the cattle met with in different parts of India, should however convince anyone experienced in cattle-breeding that few of these breeds can claim to be genetically pure, and, though it is true that the same might be said of many of the now well-established breeds of other countries, there is this important difference.

## BREEDING PRACTICE IN OTHER COUNTRIES IN THE PAST.

In the formation of the European breeds of cattle, the greatest care was taken to breed constantly to a definite type; aberrations from the accepted type were carefully eliminated; herd-books were formed; and after carefully selected cattle had been admitted to the original registration, the books were closed to all except the progeny of registered parents. Moreover, breed characteristics were authoritatively defined and are now generally accepted by judges all over the world,

so that a great measure of similarity and continuity in breeding policy was secured from generation to generation.

Similar methods have been applied in the improvement of other kinds of farm-stock, while it is well known that the superiority and true breeding qualities of English Thoroughbred and Arab race-horses are attributable largely to the care with which pedigrees have been registered through many generations.

### Elimination of inferior types.

Deviations from the accepted type have undoubtedly occurred in the progeny of even such registered parents as these, but competition in the show ring in the case of cattle and the severe test of the race-course in the case of race-horses, have ensured the elimination of undesirable strains from all the best herds and studs.

Moreover, the castration of all males not required for breeding, and the Government policy now being pursued for the elimination of scrub bulls, have also done much in recent years to purify the blood of ordinary cattle in countries where the improvement of live-stock has been seriously taken in hand.

Consequently typical representatives of most of the well-established European breeds can be relied upon to breed true to type, while the type of all carefully registered breeds is bound to become more and more a fixed one so long as the closed herd-book policy is strictly adhered to.

### Harm done by fancy breeding, not subject to strict control.

That, on the other hand, infinite harm can be done to well-defined breeds by indiscriminate breeding for fancy points, without strict control by an official breed society, and with no utility test in the show ring, has been amply demonstrated, for instance, by the harm which has been done, in recent years, to nearly all breeds of sporting dogs, by the introduction of alien strains of blood in order to accentuate some fancy point, and by ill-considered in-breeding, to fix the type, without any regard for vigour and constitution in the progeny.

As originally bred, old-fashioned sporting dogs were hardy, healthy animals, eminently suited to the practical purposes for which they were required, but many of their descendants have now become so debased as to be quite useless for all practical purposes.

### Breeding practice in India in the past.

In India the position is different but much harm has also been done by indiscriminate breeding among farm live-stock of all kinds.

The number of so-called breeds is legion ; there is a constant movement of cattle of various breeds from one end of India to the other, a large number of which are

entire ; there are no herd-books nor accurate records of services ; and it is unfortunately true that in many cases bulls of no particular breed are let loose in the villages to propagate their species at will.

Moreover, records show that in the past it was the custom for potentates to present each other with bulls, sometimes in considerable numbers, many of which were undoubtedly used for crossing with local cattle of an entirely different type. In this way the existence to-day of certain more or less well-defined breeds, in localities far distant from the areas in which cattle of a similar type are now met with, may well be accounted for, and it is not to be wondered at that it is difficult to-day to find well-defined breeds of Indian cattle which, on critical examination, show the strict adherence to type expected in pure-bred stock of long pedigree.

### THE FORMATION OF THE EXISTING IMPROVED BREEDS OF INDIAN CATTLE.

As to how majority of the existing more or less well-established improved breeds were originally formed, from the few fundamental types of Indian cattle which remain, difference of opinion may arise, but there is no doubt that a great deal of indiscriminate cross-breeding must have occurred in the border areas where two or more of the basic types would be bound to meet.

To have established such well-marked breeds as, for instance, the Kankrej, Kangyam, and Ongole breeds, long continued and careful breeding to a definite type, with rigid elimination of every variation, must, however, have been practised, and it is clear that this work must have been carried on from generation to generation.

Such work is largely a work of time and practical experience and cannot be learnt entirely by the experimental study of genetics in smaller animals or plants, however valuable such study may be in explaining the results obtained.

Owing to the time and expense required to work out genetical factors in slow breeding and costly animals, live-stock improvement among the larger domesticated animals has still to be based on the breeding practice of the outstanding breeders of all times, which has now become traditional, and the fine points of which can only be appreciated by those who have a natural flair for breeding, and who have acquired an intimate knowledge of the class of stock concerned by practical experience.

It is evident however that the breeders who were capable of producing such even results must have thoroughly understood the fundamental principles which underlie all successful breeding of the larger domesticated animals, and judging from the care with which they still look for traditional breed-characteristics in the selection of their breeding stock, there is no doubt that this knowledge is still fairly widely applied by practical breeders in India, particularly among the professional cattle-breeders, who maintain considerable herds in large grazing areas, and are able to keep them reasonably free from the accidental intrusion of alien blood.

## APPEN

*Cost per acre ploughed—Trial No. 2—Plough*

| Tractor | Selling price of tractor | Plough | Selling price of plough | Acreage | Time taken to plough one acre | Kerosene used during test | Cost of kerosene per acre | Petrol used during test | Cost of petrol per acre |
|---|---|---|---|---|---|---|---|---|---|
| | Rs. | | Rs. | | Hr. Mins. | Gals. pints | Rs. A. P. | Pints gills | Rs. A. P. |
| 22/36 McCormick-Deering International. | 4,660 | 3-bottom McCormick-Deering mouldboard plough. | 450 | 1 | 1 13 | 2 6 | 2 3 0 | 1 0 | 0 2 1 |
| 10/20 McCormick-Deering International. | 3,110 | 2-bottom McCormick-Deering mouldboard plough. | 310 | 1 | 1 49 | 2 5 | 2 1 5 | 0 1½ | 0 0 9 |
| 14/28 Rushton (Crawler type). | 6,600 | 3-bottom Rud-Sack-Leipzig mouldboard plough. | 625 | 1 | Failed to finish. | .. | .. | .. | .. |
| | | | | | | | | Gals. pints | |
| Caterpillar 15 | 4,750 | 3-bottom McCormick-Deering P. & O. disc plough. | 514 | 1 | 1 34 | Running on petrol only. | | 3 4 | 3 9 9 |
| 12/27 Fordson. | 2,600 | 2-bottom Oliver disc plough. | 425 | 1 | 1 55 | Running on petrol only. | | 3 6 | 3 13 11 |
| 14/28 Rushton (4-wheel model). | 3,950 | 4-bottom Ransome disc plough. | 750 | 1 | Did not compete. | .. | .. | .. | .. |
| | | | | | | | | Pints gills | |
| 20/27 Cletrac. | 4,650 | 5-bottom John Deere disc plough. | 1,010 | 1 | 0 59 | 3 ½ | 2 7 2 | 1 1 | 0 2 7 |
| 12/20 Cletrac. | 3,350 | 3-bottom Oliver mouldboard plough. | 350 | 1 | 1 20 | 2 6 | 2 3 0 | 0 2 | 0 1 0 |
| 8/16 McCormick-Deering International "Farmall". | 3,130 | 2-bottom mouldboard McCormick-Deering plough. | 310 | 1 | 1 45 | 2 5 | 2 1 5 | 0 ½ | 0 0 3 |

DIX II.

*ing on half-acre bunded hard-baked plots.*

| Cost of lubricating oil per acre | Cost of grease per acre | Depreciation at 20 per cent. per annum. Cost per acre | Interest on capital at 10 per cent. per annum. Cost per acre | Spares at 5 per cent. per annum on capital outlay. Cost per acre | Wages. Head driver Rs. 80 per month. Ploughman Rs. 40 per month. Cost per acre | Cost per acre ploughed | Marks | REMARKS |
|---|---|---|---|---|---|---|---|---|
| RS. A. P. | RS. A. P. | RS. A. P. | RS. A. P. | RS. A. P. | RS. A. P. | RS. A. P. | | |
| 0 2 6 | 0 0 2 | 1 0 8 | 0 8 4 | 0 4 2 | 0 9 0 | 4 13 11 | 45 | |
| 0 2 6 | 0 0 2 | 1 0 6 | 0 8 3 | 0 4 1 | 0 13 6 | 4 15 2 | 40 | |
| .. | .. | . | . .. | . | .. | .. | .. | Failed to finish owing to trouble with plough. |
| 0 2 6 | 0 0 2 | 1 5 11 | 0 10 11 | 0 5 6 | 0 11 7 | 6 14 4 | 22 | |
| 0 2 6 | 0 0 2 | 0 15 6 | 0 7 9 | 0 3 10 | 0 14 3 | 6 9 11 | 24 | |
| .. | .. | .. | .. | .. | .. | .. | .. | Could not start owing to magneto trouble. |
| 0 2 6 | 0 0 2 | 0 14 10 | 0 7 5 | 0 3 8 | 0 7 4 | 4 13 8 | 46 | |
| 0 2 6 | 0 0 2 | 0 13 1 | 0 6 6 | 0 3 3 | 0 9 11 | 4 7 5 | 50 | |
| 0 2 6 | 0 0 2 | 1 0 0 | 0 8 0 | 0 4 0 | 0 13 0 | 4 13 4 | 47 | |

APPEN

*Cost per acre harrowed—Trial No 3.—*

| Tractor | Selling price of tractor | Harrow | Selling price of harrow | Acreage | Time taken to complete the test | Time taken to harrow one acre | Kerosene used during the test | Cost of kerosene per acre | Petrol used during the test |
|---|---|---|---|---|---|---|---|---|---|
| | Rs. | | Rs. | | | | | | |
| 22/36 McCormick-Deering International. | 4,660 | Wheatland 12-disc. | 835 | 1·75 | Failed to finish | | | .. | .. |
| 10/20 McCormick-Deering International. | 3,110 | 24-disc harrow. | 500 | 1·75 | Failed to finish | | | .. | .. |
| 14/28 Rushton (Crawler type). | 6,600 | 28-disc harrow. | 425 | 1·75 | Failed to finish | | | .. | .. |
| | | | | | Mins. | Mins. | | | Gal. pints |
| Caterpillar 15 | 4,750 | 28-disc harrow. | 425 | 1·75 | 44 | 25 | Running on petrol only. | | 1 2 |
| 12/27 Fordson. | 2,600 | 28-disc harrow. | 450 | 1·75 | 39 | 22 | Running on petrol only | | 1 6 |
| 14/28 Rushton (4-wheel model). | 3,950 | Did not compete | | .. | .. | .. | .. | .. | .. |
| | | | | | | | Gal. pints | Rs. A. P. | Gill |
| 20/27 Cletrac. | 4,650 | Roderick 32-disc. | 425 | 1·75 | 44 | 25 | 1 5 | 0 12 0 | ½ |
| 12/20 Cletrac. | 3,350 | Oliver cultipacker. | 285 | 1·75 | 42 | 24 | 1 6 | 0 12 9 | 1 |
| 8/16 McCormick-Deering International "Farmall". | 3,130 | 12-disc harrow. | 225 | 1·75 | 39 | 22 | 0 7 | 0 6 4 | ½ |

DIX III.

*Harrowing on open land.*

| Cost of petrol per acre | Cost of lubricating oil per acre | Cost of grease per acre | Depreciation at 20 per cent. per annum. Cost per acre | Interest on capital outlay at 10 per cent. per annum. Cost per acre | Spares at 5 per cent. per annum on capital outlay. Cost per acre | Wages. Head driver Rs. 80 per month. Ploughman Rs. 40 per month. Cost per acre | Cost per acre harrowed | Marks | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| Rs. A. P. | Rs. A. P. | Pies | Rs. A. P. | Rs. A. P. | Rs. A. P. | Rs. A. P. | Rs. A. P. | | |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | No harrow available. Used disc plough which was not suitable. |
| .. | .. | | .. | .. | .. | .. | .. | .. | Link frame of harrow broke. |
| .. | .. | .. | | .. | .. | .. | .. | .. | |
| 0 11 10 | 0 1 0 | 1 | 0 5 9 | 0 2 10 | 0 1 5 | 0 3 1 | 1 10 0 | 20 | |
| 1 0 6 | 0 1 0 | 1 | 0 2 11 | 0 1 5 | 0 0 9 | 0 2 9 | 1 9 5 | 19 | |
| .. | .. | . | .. | .. | .. | .. | .. | .. | |
| 0 0 3 | 0 1 0 | 1 | 0 5 7 | 0 2 10 | 0 1 5 | 0 3 1 | 1 10 3 | 20 | |
| 0 0 6 | 0 1 0 | 1 | 0 3 11 | 0 1 11 | 0 1 0 | 0 3 0 | 1 8 2 | 21 | |
| 0 0 2 | 0 1 0 | 1 | 0 3 4 | 0 1 8 | 0 0 10 | 0 2 9 | 1 0 2 | 25 | |

APPEN

*Cost per acre ploughed—**Trial** No. 5—*

| Tractor | Selling price of tractor | Plough | Selling price of plough | Acreage | Time taken to complete test | | Time taken to plough an acre | | Kerosene used during test | | Cost of kerosene per acre | | | Petrol used during test | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rs. | | Rs. | | Hr. | Mins. | Hr. | Mins. | Gal. | pints | Rs. | A. | P. | Gill | |
| 22/36 McCormick-Deering International. | 4,660 | 3-bottom mouldboard plough McCormick-Deering. | 450 | 0·75 | 0 | 54 | 1 | 12 | 1 | 4 | 1 | 9 | 6 | ½ | |
| 12/20 McCormick-Deering International | 3,110 | 2-bottom mouldboard plough McCormick-Deering. | 310 | 0·75 | 0 | 57 | 1 | 16 | 1 | 3 | 1 | 7 | 7 | ½ | |
| | | | | | | | | | | | | | | Gals. | pints |
| 14/28 Rushton (Crawler type). | 6,600 | 3-bottom mouldboard Rud-Sack-Leipzig plough. | 625 | 0 75 | 1 | 12 | 1 | 36 | Running on petrol only. | | | | | 2 | 2 |
| Caterpillar 15 | 4,750 | 2-bottom Oliver mouldboard plough. | 450 | 0·75 | 1 | 15 | 1 | 40 | Running on petrol only. | | | | | 1 | 5 |
| 12/27 Fordson. | 2,600 | 2-bottom Oliver mouldboard plough. | 310 | 0·75 | 1 | 7 | 1 | 30 | Running on petrol only. | | | | | 2 | 5 |
| 14/28 Rushton (4-wheel model). | 3,950 | 4-bottom Ransome disc plough. | 750 | 0·75 | Did not compete. | | | | | | | | | | |
| | | | | | | | | | | | | | | Gill | |
| 20/27 Cletrac. | 4,650 | 4-bottom John Deere disc plough. | 850 | 0·75 | 0 | 50 | 1 | 7 | 1 | 6½ | 1 | 15 | 2 | ¼ | |
| 12/20 Cletrac. | 3,350 | 3-bottom Oliver mouldboard plough. | 350 | 0·75 | Disqualified | | | | | | .. | | | . | |
| 8/16 McCormick-Deering International. "Farmall". | 3,130 | 2-bottom mouldboard McCormick-Deering plough. | 310 | 0·75 | 0 | 55 | 1 | 18 | 1 | 1½ | 1 | 4 | 1 | ½ | |

DIX IV.

*on bunded slush plots in water.*

| Cost of petrol per acre | Cost of lubricating oil per acre | Cost of grease per acre | Depreciation at 20 per cent. per annum. Cost per acre | Interest on capital outlay at 10 per cent. per annum. Cost per acre | Spares at 5 per cent. per annum on capital outlay. Cost per acre | Cost of labour per acre. Driver's wages Rs. 80 per month. Ploughman Rs. 40 per month | Cost per acre ploughed | Marks | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| Rs. A. P. | Rs. A. P. | Pies | Rs. A. P. | Rs. A. P. | Rs. A. P. | Rs. A. P. | Rs. A. P. | | |
| 0 0 3 | 0 2 6 | 2 | 1 0 5 | 0 8 2 | 0 4 1 | 0 8 11 | 4 2 0 | 43 | |
| 0 0 3 | 0 2 6 | 2 | 0 11 6 | 0 5 9 | 0 2 10 | 0 9 5 | 3 8 0 | 47 | |
| 3 1 6 | 0 2 6 | 2 | 1 14 9 | 0 15 4 | 0 7 8 | 0 11 10 | 7 5 9 | 17 | |
| 2 3 8 | 0 2 6 | 2 | 1 7 1 | 0 11 6 | 0 5 9 | 0 12 4 | 5 11 0 | 30 | |
| 3 6 3 | 0 2 6 | 2 | 0 11 7 | 0 5 10 | 0 2 11 | 0 11 1 | 5 8 4 | 29 | |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | |
| 0 0 2 | 0 2 6 | 2 | 1 0 5 | 0 8 2 | 0 4 1 | 0 8 3 | 4 6 11 | 40 | |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | Disqualified for not completing plot and detaching plough. |
| 0 0 3 | 0 2 6 | 2 | 0 11 2 | 0 5 7 | 0 2 10 | 0 9 0 | 3 3 7 | 50 | |

# APPENDIX V.

*Table of marks.*

| Tractor | Agent | Test No. 1 | | Test No. 2 | | Test No. 3 Harrowing cost per acre Possible 25 | Test No. 4 Ease of manipulation Possible 10 | Test No. 5 | | Test No. 6 General construction Possible 10 | Test No. 7 General finish Possible 5 | Total Possible 275 | Placing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ploughing Possible 25 | Cost per acre Possible 50 | Ploughing Possible 25 | Cost per acre Possible 50 | | | Ploughing Possible 25 | Cost per acre Possible 50 | | | | |
| 22/36 International. | C. R. Cowie & Co. | 22 | 43 | 15 | 45 | .. | 5 | 20 | 43 | 10 | 4 | 207 | 3rd |
| 10/20 International. | C. R. Cowie & Co. | 20 | 47 | 15 | 40 | .. | 7 | 18 | 47 | 7 | 3 | 204 | 4th |
| 14/28 Rushton (Crawler). | Marshall Cottrell & Co. | 15 | 17 | Not completed. | .. | .. | 8 | 8 | 17 | 9 | 4 | 78 | 8th |
| Caterpillar 15. | William Jacks & Co. | 24 | 31 | 22 | 22 | 20 | 10 | 2 | 30 | 9 | 5 | 175 | 5th Bronze Medal. |
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| 14/28 Rushton. | Marshall Cottrell & Co. | 12 | 37 | Did not enter. | .. | .. | 6 | Did not enter. | .. | 8 | 3 | 66 | 9th |
| 20/27 Cletrac. | U Po Hlaing & Co. | 16 | 49 | 16 | 46 | 20 | 9 | 10 | 40 | 8 | 3 | 217 | 2nd Silver Medal. |
| 12/20 Cletrac. | U Po Hlaing & Co. | 18 | 50 | 14 | 50 | 21 | 9 | Disqualified. | .. | 8 | 3 | 168 | 6th |
| 8/16 Farmall. | C. R. Cowie & Co. | 18 | 45 | 18 | 47 | 25 | 8 | 23 | 50 | 8 | 4 | 246 | 1st Gold Medal. |
| Caterpillar 10. | William Jacks & Co. | | | Did not | compete | | | | Did not | compete | | | |
| International (Crawler). | C. R. Cowie & Co. | | | Did not | compete | | | | Did not | compete | | | |

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entire; there are no herd-books nor accurate records of services; and it is unfortunately true that in many cases bulls of no particular breed are let loose in the villages to propagate their species at will.

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### Harm done by indiscriminate cross-breeding.

The harm done by cross-breeding in the cattle of breeders of this type is not therefore likely to be very great but among small breeders who maintain a few cows only, in and around a village, which are herded daily with other cattle and are exposed to the risk of being served by the bulls, often of very inferior type, which are permitted to roam at will in the villages, the harm done must be very great, even though better bulls may be available.

Moreover, owing to the rapid contraction of grazing areas which has taken place, the damage caused by such bulls has been accentuated during recent years by the inadequate maintenance provided in villages where insufficient free grazing areas exist.

In the past, when an extensive class of professional cattle-breeders existed, who could be depended on to prevent indiscriminate mating and to carry on a traditional system of selection, this uncontrolled cross-breeding in villages was probably the main cause of the production of the large numbers of nondescript cattle which may be seen to-day throughout India, and the maintenance of which constitutes such a heavy tax on the live-stock industry.

Controlled cross-breeding will do no harm and much good, if carried on long enough to stabilize a type, but it is obvious that a vast amount of indiscriminate crossing must have occurred in India in the past, as a result of the constant movement of cattle, including entire males, which has taken place in the course of wars and raids, and which still occurs annually, on a very large scale, in the course of trade and in order to reach fresh grazing grounds.

### The basic breeds of Indian cattle.

In spite of all this crossing, however, distinct types still predominate over certain large areas, and it seems that at least four or five distinct basic types must have existed in India originally. For instance in the North, from Baluchistan to the Central Provinces, large white cattle such as the Bhagnari, Hariana and Malvi breeds, may be met with over large areas in a comparatively pure state. In Mysore and Northern Madras, the very distinct Mysore type of cattle, with their characteristic formation of head and horns, are predominant, while in the West the highly peculiar Gir cattle are still to be found in a pure state in their native forests, while the blood of this evidently pre-potent breed can be readily detected in a large proportion of the cattle of Western India. Other breeds, which are obviously only variants of these basic types, produced by changed conditions of existence, selective breeding, or cross-breeding with other types, are also commonly met with.

Further, all over India, particularly in the hills and less highly fertile areas, small reddish black, or parti-coloured cattle are met with with great persistency, and are so similar in type as to suggest that they too may represent one of the original types of Indian cattle.

Between these basic types innumerable gradations occur, and to obtain true breeding strains from such heterogeneous stock must obviously entail great care in selection, and long-continued and strictly controlled breeding to a definite type.

## IN-BREEDING.

From the records of all the great practical breeders of the past it is clear that the surest and most satisfactory way of fixing a type is to in-breed closely to outstanding animals which conform strictly to the desired type.

This policy, in combination with good feeding and healthy conditions, has been, and is still, pursued to a very considerable extent by the successful breeders of almost every outstanding breed of domesticated animal. There is, unfortunately, a definite danger of perpetuating any undesirable characters which may happen to exist in the selected strain, and of loss of vigour if ill-considered in-breeding is persisted in through a number of successive generations, but experience has shown that the danger of loss of vigour and constitution from in-breeding has been much exaggerated.

Loss of vigour and constitution are in fact commonly more pronounced in the mongrel animals produced by repeated indiscriminate crossing than in the pure-bred stock of pedigree herds which have been closely in-bred at the start to establish a pure strain.

In India at present under the existing conditions in villages, the danger of harm from in-breeding is certainly far less than from indiscriminate crossing and from the frequent changes in breeding policy which have taken place in British India in the past.

## IMPORTANCE OF CONTINUITY OF POLICY IN DEFINITE AREAS.

Nowadays, with the introduction of Government schemes for live-stock improvement all over the country, usually by the employment of improved sires of alien blood, there is grave danger that an even greater number of cattle of no particular breed will be produced than in the past, and eventually degenerate into mongrels in the villages, unless great care is taken to provide for such continuity of breeding policy as will insure the eventual elimination of nondescript blood in the areas dealt with.

That much good can be done by the introduction of improved bulls of a type suitable for the district concerned, and by better feeding, there is no doubt, but the fact that harm may also result, if a definite policy is not persisted in with the same blood, should not be overlooked. For this reason, until many more suitable bulls become available than at present, a policy of concentrating cattle improvement on certain selected areas and herds, and only extending to others as sufficient improved bulls become available, is undoubtedly sound.

### Necessity for organization on a broad basis.

Provincial Governments are now producing as many bulls as possible in Government farms, for issue to breeders, but this must always be a slow and expensive process, and if satisfactory progress is to be made, within a reasonable time, it is evident that live-stock improvement in India will have to be organized, and consistently applied, on a much larger scale than is the case at present in most provinces.

Further, if the work were placed on a broader basis for the whole of India, with the help of breeders and large landowners all working with their own cattle to the same end, the results achieved would be far greater and more permanent than can ever be achieved by the issue of such comparatively small numbers of improved bulls as can be reared on Government farms.

Successful live-stock improvement in fact, now as ever, demands that the work shall be carried out on such a scale that large numbers can be dealt with, and shall be controlled by some permanent authority or by tradition, which will obviate frequent changes of policy.

### Ill-considered changes of policy fatal to success.

The Royal Commission on Agriculture in India has drawn attention to the fact that much of the ill-success which attended official schemes for live-stock improvement in India, in the past, was due to the frequent changes of policy and interest which had occurred, and the writer has himself recently seen a striking instance of a valuable strain of pure-bred cattle, which had been built up with great care and at considerable expense, being entirely vitiated, and the results of a carefully prepared breeding scheme lost, because of a change of policy, introduced on a change of control.

Enthusiastic theoretical students of genetics, or even those who have been accustomed to the practical breeding of small animals or plants, of which almost unlimited numbers can be dealt with, are apt not to realize the paramount necessity for long-continued policy to a definite end in all breeding operations with the larger domesticated animals, of which only comparatively small numbers can be bred within a generation. On the other hand, experienced breeders of such stock know only too well how much time, care, and expense are required to isolate and fix a true-breeding strain, and would never make any change in an established breeding policy without most careful consideration.

### Necessity for permanent control by unchanging authority.

If permanent results are to be obtained, therefore, on a sufficiently broad scale to have any considerable economic effect, it seems essential that cattle-breeding policy in India should be permanently controlled by associations of live-stock officials and practical breeders, and not subject to the direction of any one official, who may be changed at any time.

As a preliminary to such control careful surveys of all the breeds which are considered worth retention would require to be made, and an authoritative decision arrived at as to the distinctive characteristics which should be demanded in typical representatives of each breed. When agreement had been reached, these characteristics would require to be carefully defined and registered as the points on which the breed should be judged, and might in course of time form the basis of herd-books for Indian breeds of cattle, without which live-stock improvement in this country must always be severely handicapped.

The Royal Commission on Agriculture in India did not consider the establishment of herd-books for Indian breeds practicable, and it is realized that it will be difficult to ensure accurate registration of matings for a long time to come.

## Preservation of basic breeds.

Unless something is done, however, to define and preserve the few pure basic strains of blood which still exist, there is grave danger that some of them will be entirely lost. For example, pure specimens of the Gir breed, which it is evident constitutes the basis of a large number of our best milking and dual-purpose breeds of Indian cattle, are already difficult to obtain, even in their own country, and as the best are now being exported in considerable numbers to America, the necessity for the immediate protection of this highly specialised and valuable breed is very apparent.

It will never be possible for any Provincial Government to establish the large number of breeding farms which would be required to preserve every useful breed, but the preservation of such a valuable basic breed as this should justify special measures.

## Conclusion.

Before anything really effective can be achieved, accurate surveys of the present position; authoritative definition of the distinctive characteristics of the various breeds; and some form of permanent control of breeding policy, similar to the control exercised by breed societies over breeding in other countries appear to be essential.

By these means it should be possible to insure definition and continuity of policy and to secure the permanent interest of some of the more influential landowners and zemindars in official schemes for live-stock improvement, which is so much to be desired, while it might perhaps be hoped that they would induce other wealthy landowners to take up stock-breeding as a hobby, as is done by so many landowners in Europe, for the benefit of the live-stock industry.

This is one of the most practical and productive methods which can be devised for patriotic citizens to help their country, and cattle-breeding in particular ought to be very popular in India, because of the veneration with which the cow is regarded.

# CONTROL OF THE FOOT-ROT DISEASE OF *PAN* (*PIPER BETEL*) IN THE CENTRAL PROVINCES.

BY

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In many parts of the Central Provinces and Berar, *pan* (*Piper betel*) is one of the important and lucrative garden crops; but during the last few years, in important *pan*-growing centres, like Ramtek Tahsil, Drug and Malkhed, its cultivation is completely given up, because of the heavy losses due to the incidence of the foot-rot disease, caused by *Phytophthora parasitica* Dast., which has already been described [Dastur, 1927]. Wherever this disease has established itself, *pan* gardens are completely wiped out.

Since 1926, experiments have been carried out to find some means of controlling the disease. At first these experiments were conducted only at Ramtek, but since the beginning of this year remedial measures are also being tried at Bhandara. The results achieved so far have been encouraging, and it is proposed to give a short account of the work done. As the disease is caused by a fungus living in the soil, which attacks the underground parts of the plant, once it is infected, it cannot be saved from the after-effects of the disease. Consequently only preventive measures are possible for ensuring a healthy growth of the plants. These preventive measures, in the case of a crop like *pan*, would consist either of keeping the soil free from the fungus causing the disease, as the infection is from the soil, or of growing resistant varieties.

No resistant varieties have so far been tried, except Bhabna on a very small scale. It was obtained last year from Bengal, through the courtesy of the District Agricultural Officer, 24-Parganas, Calcutta. Only a few cuttings struck roots, and the plants developed from these cuttings are so far doing well, though they have been planted in a soil where the local varieties get infected. The two varieties commonly cultivated in these Provinces are Kapuri and Bangla; both are more or less equally susceptible, though the *baris*, or *pan*-growers, believe that Bangla is more susceptible.

Various fungicides have been tried to sterilize the soil and to prevent the infection of the soil by this fungus. Uspulun wet was used at the rate of half a pound in 25 gallons of water per line of 150 feet, Solomia at the rate of 10 pints in 50 gallons of water per line of 150 feet, Quasol—a three per cent. solution—at the rate of 50 gallons per line of 150 feet, and Bordeaux Mixture in different strengths; each of these was first applied a few days before the *pan* cuttings were planted, and then the application was continued once a month.

In a second series of experiments, before the cuttings were planted, dry fungicides were also tried ; *e.g.*, Uspulun dry at the rate of 2½ lb. and calcium cyanamide at the rate of 2 lb., each per line of 150 feet, and slaked lime. The former two were well mixed with the soil, and the latter was sprinkled on the ridges in sufficient quantity to cover them completely. Calcium cyanamide for the first few months after it was applied had both a fertilizing and fungicidal effect. The plants were better in growth and fewer plants were diseased than in other series, barring that of Bordeaux Mixture ; but its protective value did not last beyond about four months. More and more plants began to die and ultimately there were hardly any living plants in this series. Uspulun wet also had some effect in controlling the disease, but not as much as calcium cyanamide ; and like the latter its effect was only for the first few months. The other fungicides, except Bordeaux Mixture, had no effect in controlling the disease.

As Bordeaux Mixture was the only fungicide which controlled the incidence of the disease, further experiments were continued with only this fungicide.

At first Bordeaux Mixture of 5-5-50 strength once a month was tried. It proved effective in controlling the disease, but the concentration was found to have a burning effect on the tender shoots and leaf-buds. The growth of the plants was also retarded. After some trials it was found that a mixture of 2-2-50 strength did not damage the shoots or the leaf-buds and did not retard the growth of the plants. This concentration, applied once a month at the rate of 25 gallons per line of 150 feet, has completely controlled the disease for the last four years in one garden. The effect of this fungicide in this garden, or *tanda*, is very conspicuous. This is one of those gardens in Ramtek where it has been impossible to grow *pan* because of the disease. The land in this garden is owned by several *baris*, or *pan*-growers ; of whom only one agreed to get his block of 15 lines of *pan* treated. To-day his is the only block with a luxuriant growth of mature *pan* plants. The remaining parts of the *tanda* on either side of this treated block are allowed to run to weed, in spite of annual attempts made by their owners to replant their land with *pan*. The plants in these parts gradually get infected and die, and by the middle of the first monsoon there is hardly a single healthy plant available. In spite of the close proximity of infective material, the treated block has remained free from disease. As at Ramtek the life of a *pan* garden is only three to four years, this treated *pan* garden will be given up by the end of the year and a new *tanda* will be erected for planting new cuttings. The owner of the treated block has therefore realised the full value of his crop in these three to four years, on account of the treatment given to his garden, and he is the only *bari* in Ramtek who has a four-year old garden full of healthy *pan* vines.

A duplicate series of experiments was carried out in another garden which was also badly infected. But in this garden the experiments were done only for two years, from 1926 to 1928. During this period the plants remained quite healthy

and had a good growth. Seeing that the plants were doing well, in 1927 another *bari* planted his plot of land immediately adjoining this experimental area; but he did not get his land treated with the fungicide. This newly planted area was soon infected, and in less than six months it was allowed to run to weed. In 1928 the owner of the experimental garden wanted back his land and so further treatment had to be discontinued. In less than six months the garden became badly infected and had hardly a few living plants.

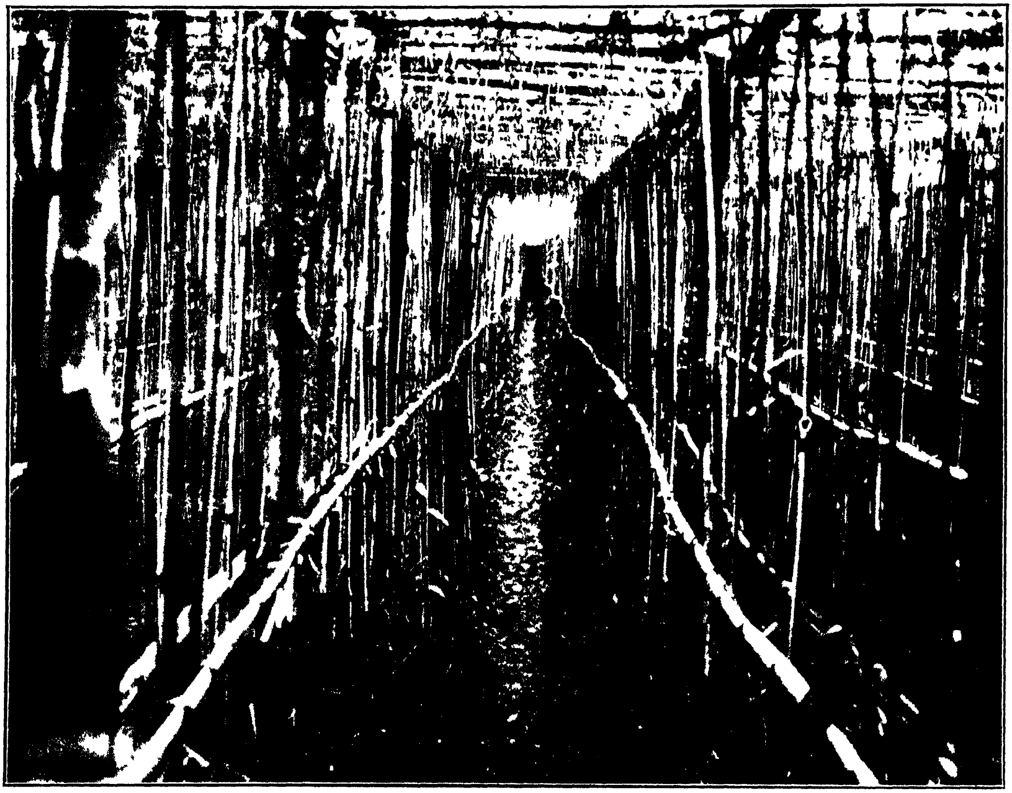
These two pieces of land in the experimental gardens were given to the Department in 1926 for a period of two years on the condition that we planted these gardens and incurred all the expenses necessary for the experiments and for the making and proper upkeep of the gardens; the produce, if any, was our property. At the end of two years either we could discontinue the experiments and give back the gardens to their respective owners or they could claim back their land with the *tanda* and the plants growing on it. The owner of the first garden was anxious to have further experiments made, being satisfied with the results obtained; and so the experiments were continued in his garden on the condition that he was to incur all the running expenses of the garden and he was to have the produce and that we would do the necessary experiments, at our cost. But the owner of the second garden claimed back his land as he was optimistic enough to hope that as the garden was free from disease for two years, it would not be again infected. As already noted, his optimism was not realised and the progressive spirit of the first garden-owner has resulted in his realising the full value of his garden.

Last year another *bari* volunteered to cultivate his land and have a *tanda* if the Agricultural Department would help him in treating his *tanda*. He has planted 11 lines, each 225 feet long. Bordeaux Mixture is supplied to him free and is applied under the supervision of an assistant. All the 11 lines were treated with Bordeaux Mixture of 2-2-50 strength before cuttings were planted. Of these 11 lines, five are being treated with 1-1-50 Bordeaux Mixture once in two months and the remaining six lines are treated with 2-2-50 Bordeaux Mixture once in three months. So far there has been no disease in this treated block of the *tanda*. There are other lines on either side of this block, and the disease has not failed to take a heavy toll from these untreated lines.

In Ramtek, there is one garden planted last year which is not being treated but still the plants are quite good and healthy. The water-supply of the garden is taken from a well immediately near the garden and not from one of the many tanks of Ramtek. Perhaps it is the source of the water-supply that may account for the healthy state of the plants, or that the soil is not infected.

At present in Ramtek there are only these three gardens having a full crop of healthy plants, though every year many new gardens are planted, but unfortunately before the end of the year they are perforce allowed to run to weed as they soon become badly infected.

PLATE IV.



A portion of untreated lines in the same garden as in Plate III, fig. 1. Cuttings planted in January, 1930.

Fig. 1. A portion of treated lines in a *pan* garden. Cuttings planted in January, 1930. Photo taken on the 12th September, 1930.

Fig. 2. A comparison between treated (right) and untreated (left) lines in the same garden as in Fig. 1. Cuttings planted in January, 1930. Photo taken on the 12th September, 1930.

Last March the disease was reported from Bhandara as well. One garden which was started about two years back was very badly diseased, and the ridges showed big gaps caused by the death of plants. Immediately adjoining this garden on the left was a new garden where the cuttings had been planted about only two months back. In the first few lines adjoining the old garden, the plants had commenced to die. The growth of the plants in these lines was also poor; it was distinctly better in the lines farther away from the old garden. The several owners of the two gardens, old and new, were at first anxious to get their gardens treated.

It was thought that the old garden was evidently too far diseased for the spraying to be of any use, and so the request to treat this garden was at first refused But as some of the owners of the lines in which there were still a sufficiently large number of living plants were very anxious to try some remedial measures, it was agreed to treat only three lines. Bordeaux Mixture of 3-3-50 strength at the rate of 25 gallons per line of 150 feet was applied, after the dead and dying plants had been completely removed. The pessimistic expectations of the failure of this treatment in a garden in which the disease had been well established were entirely falsified. This one treatment has considerably checked the progress of the disease in these three lines. In April there were very few new plants diseased in this block of three lines, whereas the remaining untreated lines on either side were practically without any healthy *pan* plants. Another treatment, but of a weaker strength, *viz.*, 2-2-50, was given this month; in May not a single plant was found infected. This block of three lines with healthy plants formed a striking contrast to its desolated neighbourhood on either side. For some unknown reasons the garden-owners were averse to giving further treatments, and so no treatment was given in May, June and July. In the beginning of August they were, however, again sprayed. So far the three lines have been quite free from disease. If any further proof were needed for establishing the efficacy of the treatment, it is provided by these three green lines (Plate III) standing in a large *tanda* in which all the other lines are completely wiped out (Plate IV).

In the new garden, adjoining this old infected garden, a block of 45 lines belonging to several *baris* was offered for treatment. The lines adjoining the old garden were already infected. It was observed that the infection was spreading from line to line commencing from the old badly diseased garden. The incidence of the disease in the new garden was less as the lines were farther away from the old garden and the farthest lines were found to be entirely free from disease.

At first the whole block was treated with Bordeaux Mixture of 2-2-50 strength at the rate of 25 gallons per line of 150 feet. For further treatments these 45 lines were divided in five blocks of nine lines each. Of these five blocks, three blocks were to be treated with Bordeaux Mixture of 1-1-50 strength, but one block was to have the treatment every month, the second once in two months and the third once in three months. The remaining two blocks were to be treated with Bordeaux

Mixture of 2-2-50 strength once in two months and once in three months respectively.

After the first treatment in March no more new plants were found to be infected. In April block No. 1 was treated with Bordeaux Mixture of 1-1-50 strength. In May the garden-owners refused to continue the experiments. In August, after a great deal of persuasion, some of the owners consented to continue the treatment. So far there is no disease in the garden.

These experiments prove that if infected soil is treated with Bordeaux Mixture of 2-2-50 strength applied at the rate of 25 gallons per ridge of 150 feet length before the cuttings are planted, and if the treatment is continued once every two months after the cuttings are planted, a healthy crop is ensured. From the experiments made since last year there is evidence to show that a solution of a weaker strength, *viz.*, 1-1-50, applied once in two months may be equally effective. There is also evidence to show that in a garden in which plants are infected, further infection can be controlled by treating the ridges with Bordeaux Mixture.

It is certain that in an infected land *pan* cannot be successfully grown unless it is treated with Bordeaux Mixture ; and if the fungicide is not to be used, it would be advisable to put the land under some other crop which is not susceptible to this disease. Cereal crops may be substituted for this garden crop.

In addition to the treatment of a garden with a fungicide the sanitation of the garden is very essential. All diseased or dying plants must be removed and must not be allowed to remain, as is the usual practice, in or outside the garden, but they must be destroyed either by burning them, or burying them deep in the ground with some lime. These dead or dying plants are a grave source of infection to healthy plants. The water channels in the garden must be properly sloped so that water does not remain collected in small pools and thus cause water-logging. The irrigation channels running from the source of water-supply to the gardens should be kept clear of weeds and dead plants.

It seems necessary that a garden must be given repeated treatments from time to time even though there may be no new cases of infection from the disease in the garden. We have already seen that of the two gardens in which treatment was commenced in 1926, the one in which it was discontinued in 1928 became badly infected shortly after. It has also been observed that healthy gardens become infected. The fungus causing this disease, *Phytophthora parasitica* Dast., is common in our soils ; it has been known to attack many wild and cultivated hosts, in these Provinces, *e.g.*, castor oil plant (*Ricinus communis*), *Vinca rosea*, Tiger's Claw (*Martynia diandra*), *Clarkia* sp., pansy (*Viola tricolor*), *Petunia hybrida*, *Crinum* sp., *Iris* sp., *Eurycles amboinensis*, *Peperomia* sp. and *Chrysalidocarpus lutescens*. It is probable that there may be other hosts which are common weeds in the vicinity of *pan tandas* and which would be potential sources of infection to the *pan* plants. Fresh infection may be carried to healthy *tandas* by workmen who have been previously working in the infected ones ; or by the irrigation water which is usually

carried long distances through *katcha* open channels or drains from the source of water-supply, which is usually a tank. The irrigation channel may pass through an infected garden before irrigating a healthy garden or the water may be contaminated by infective material, such as dead or dying *pan* plants removed from gardens and carelessly thrown about the *tandas* or infected weeds growing in or about the channels. In Malkhed this fungus was once isolated from a sample of water irrigating a *pan* garden. Thus healthy gardens are very liable to be infected by the irrigation water, especially if it is brought from long distances.

Bordeaux Mixture is prepared from blue stone or crystalline copper sulphate (*morchu*), and from quicklime (*chuna-khadi*) which when slaked gives a good milk of lime. Both these ingredients for the fungicide are available in any village. Copper sulphate solution must be made in a non-metallic vessel, but quicklime can be slaked in a metal vessel. These two solutions should be mixed together in a non-metallic vessel. Bordeaux Mixture of 2-2-50 strength implies that 2 lb. of blue stone and 2 lb. of quicklime are dissolved in 50 gallons of water; for Bordeaux Mixture of 1-1-50 strength 1 lb. of each of the two constituents are dissolved in 50 gallons of water. As this fungicide must be used immediately after preparation, it is made in the garden at the time when the spraying is to be done. As there is considerable difficulty in procuring large-sized wooden vessels, stock solutions are made in wooden casks or tubs, and the mixture of the correct concentration is made with the necessary dilution in a third wooden cask. For example, to make 400 gallons of 2-2-50 Bordeaux Mixture, 16 lb. of copper sulphate and 16 lb. of unslaked lime are each dissolved in 24 gallons of water. Three gallons from each of the two stock solutions are added to a third wooden vessel containing 44 gallons of water. The mixture is roughly tested for its alkalinity. It is poured on the ridges with an ordinary watering can, or *hazara*, with its "rose" removed. The contents of one watering can of three-gallon capacity are enough for covering a length of 19 feet. The liquid is allowed to run down the slopes of the ridges and to spread on the channels on their either side.

It is economical to pick the leaves about a foot above ground level before the mixture is applied, so that their market value is not destroyed by getting stained with the mixture.

It is also advantageous to keep the lower branches of the *pan* vines free from the ground surface. This lessens the chances of the plants getting infected. It has been found that branches develop small black patches when they are in contact with the wet ground surface. These are caused by the anthracnose fungus *Glomerella cingulata*. It is a weak parasite and it slowly kills the infected branches if the plant is not healthy.

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# A NOTE ON THE DOWNY MILDEW OF SUGARCANE IN INDIA.

BY

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Downy mildew of sugarcane was first recorded in Formosa in 1909 and described by Miyake [1911]. A disease very similar to it has also been observed in Fiji [Lyon, 1911], Australia [Lyon, 1915] and Queensland, and is known under the name of "leaf stripe disease." In the Philippine Islands [Lee and Medalla, 1921; Weston, 1921] it was recorded in 1921 on some canes grown from seed-cane imported from Formosa in the previous year. It was observed in India during the summer of 1930 in Pusa on only one plant of Co. 316, and this is the first record of its occurrence in India. A good deal of search was made on this and other varieties of cane both in Pusa and in some other localities in India, but no trace of this disease has so far been found except the solitary instance recorded above.

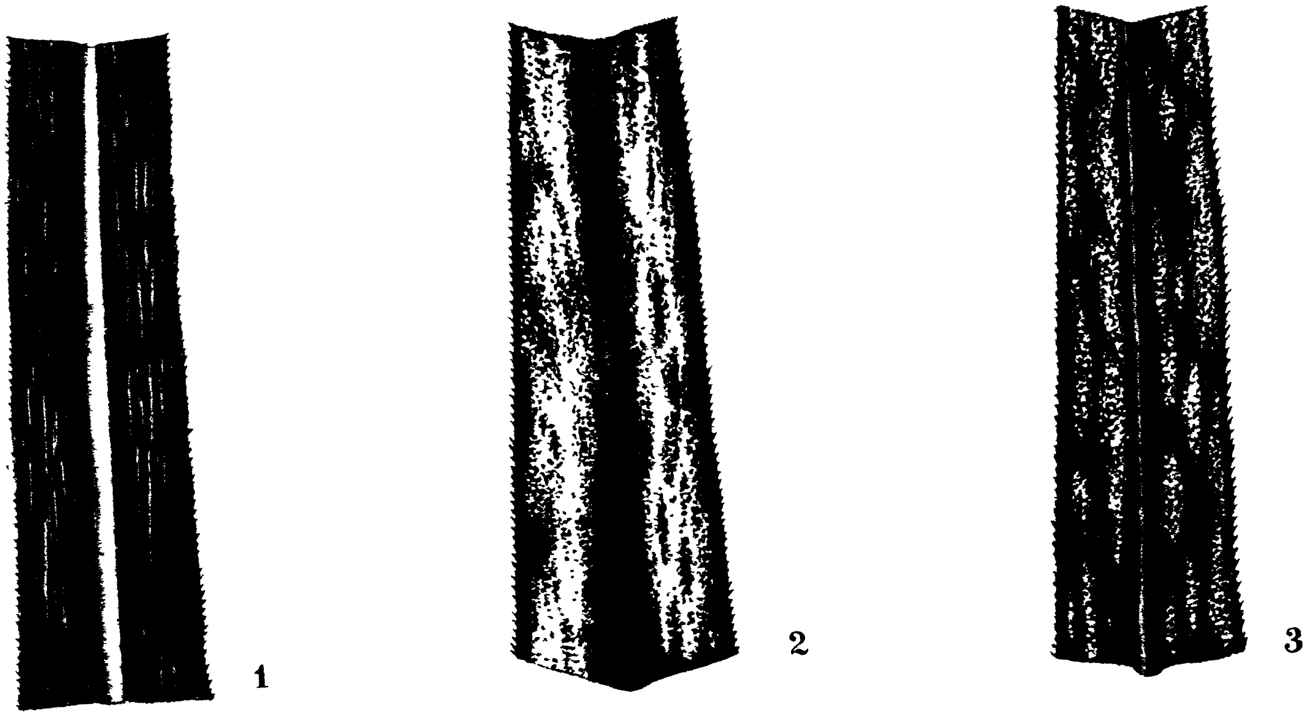
The symptoms of the disease as observed at Pusa were as follows :—The leaves had mottling like that of mosaic disease (Plate V). The light yellow spots were scattered or sometimes running together along the veins. The under-surface was covered with white downy growth due to the conidial formation. But the mottling differs from that of mosaic in the later stage as it becomes more crowded and yellowish instead of forming isolated islands of yellow and green which is the case in mosaic disease.

This disease differs from the Indian [Butler and Kulkarni, 1913] as well as the Philippine [Weston, 1920] species of *Sclerospora* on maize in that the yellow spots do not make a long chlorotic band which is characteristic of the maize *Sclerospora* species.

The mycelium travels all over the infected parts of the leaves and is more common in the mesophyll tissue, variable in size, the diameter being up to 8 $\mu$. Hyphæ penetrate the bundle-sheaths and tangled masses of hyphæ are found in all the inter-cellular spaces. Haustoria were also found in the epidermal cells. Numerous hyphal bits collect under the stoma and from these the conidiophores emerge. The haustoria are both button and finger-shaped. The former are found in the main strands, while the latter in most of the cells.

The conidiophores arise singly or in clusters of two to four from the stoma. They are bulbous at the base, then become narrow, growing broader in the middle region, branching two to four times at the tip and ending into two or three broad, conical sterigmata, one to three septate. Very often a foot-like projection is left at the base of conidiophores showing the point of attachment to the mycelium and resembling in this respect the conidiophores of *Sclerospora philippinensis* on maize,

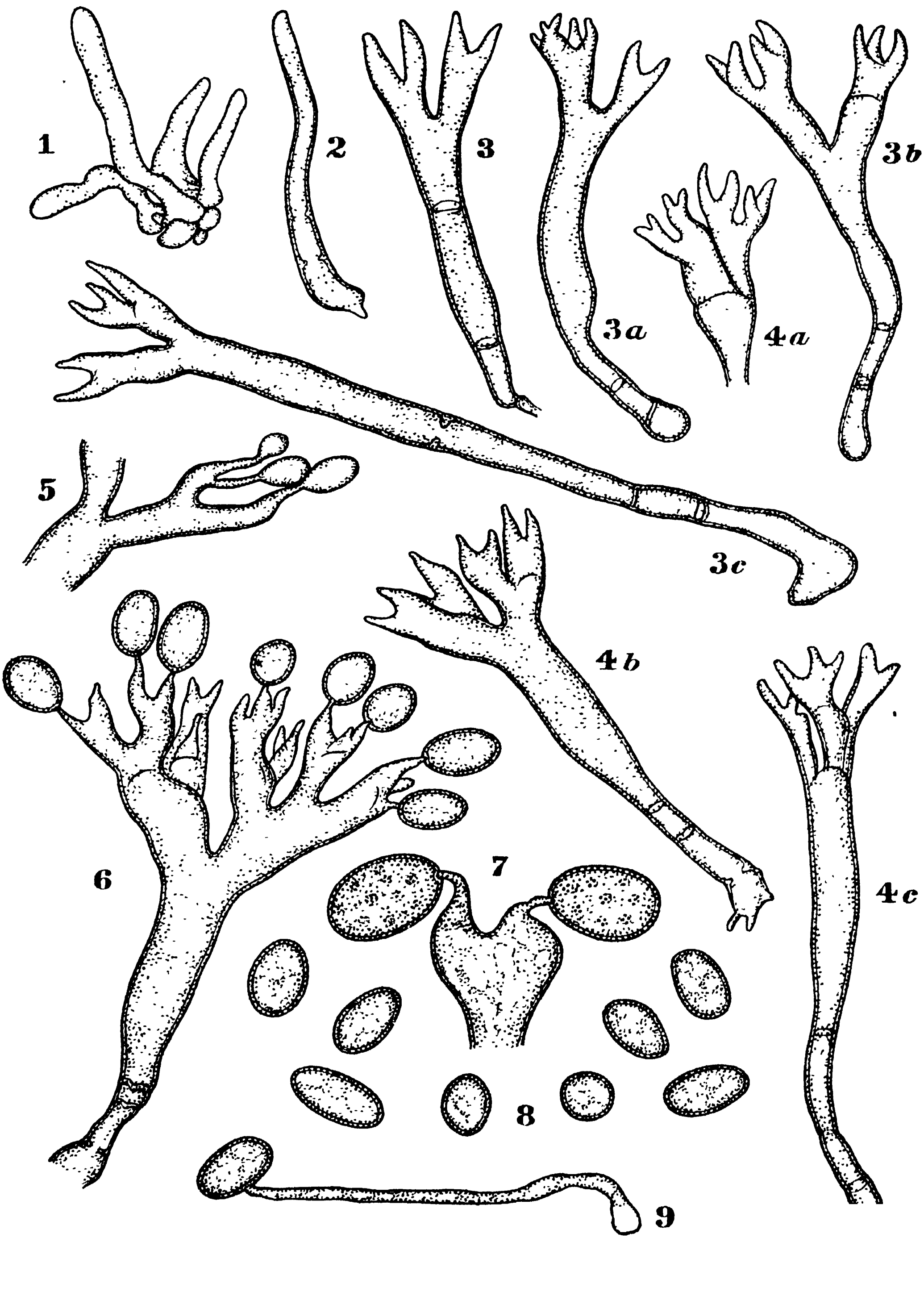
# Sclerospora on Sugarcane.



Co. 316.

PLATE VI.

# Sclerospora on Sugarcane.



They are 132-264 V 16·5—27·5 μ in diameter, the average being 186-22. The sterigmata are 4·4—27·5 μ in length (Plate VI). The conidia are elliptical or oblong, with a small papilla at the point of attachment, granular, thin-walled and germinating by a tube. They are 18·7—45·1 V 13·2—26·4 μ in diameter, the average of two hundred spores being 31·5 V 18·8 μ.

Miyake [1911] has been able to transfer the sugarcane *Sclerospora* on to cane maize and teosinte. The material available in Pusa was scanty and so inoculation experiments could not be carried out in detail. However, a few plants of cane, maize, *Sorghum*, *Pennisetum typhoideum*, *Eleusine coracana*, *Euchlæna* and *Setaria italica* were inoculated and so far only maize has taken infection.

The measurements of conodiophores and conidia fall within the limit of *Sclerospora Sacchari* as given by Miyake [1911] and Ito [1913]. The Indian species differs from *Sclerospora Sacchari* in two points, *viz.*, there was no splitting of the leaves and no elongation of the diseased stalk. As there was only one diseased plant the material was not enough to verify these points. The oogonial stage has so far not been found at Pusa. Until the points mentioned above are clearly ascertained, it cannot be definitely stated whether the Indian *Sclerospora* is identical with that described by Miyake [1911] from Formosa.

The present note is a preliminary one and has been written with a view to place before the scientific workers the fact that the downy mildew of sugarcane has for the first time been observed in India.

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## EXPLANATION OF PLATES V AND VI.

### PLATE V.—SCLEROSPORA ON SUGARCANE (Co. 316).

1. Under-surface showing leaf-mottling.
2. Under-surface showing the downy growth of the fungus.
3. Under-surface showing the spots and the downy growth of the fungus.

### PLATE VI.—SCLEROSPORA ON SUGARCANE.

1-2. Conidiophores, early stage × 347.
3-4c. Conidiophores showing stages in development with bulbous foot and septation × 347.
5. Formation of young conidia and sterigmata × 347.
6. Mature conidiophores with conidia attached × 347.
7. Highly magnified view of sterigmata and conidia × 600.
8. Conidia × 347.
9. Germinating conidium × 347.

# STUDY OF THE LOSSES OF FERTILIZING CONSTITUENTS FROM CATTLE DUNG DURING STORAGE AND A METHOD FOR THEIR CONTROL.

BY

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The most precious and the most readily available manure at hand for a farmer is his farmyard manure, which not only supplies plant food to his crops but also ameliorates the physical texture of the soil, which is an equally essential factor for the good development of the plants. Any attempt to make the best use of it never goes unrewarded.

In Western countries farmyard manure consists of the liquid and solid excretions of the farmer's live-stock with varying amounts of straw or other litter used as bedding. Indian farmyard manure, on the other hand, usually consists only of the dung, with such urine as it has absorbed, and little or no bedding material, The bedding used in the West not only serves to add to the comfort of the animal, but also absorbs the liquid excretions which thereby find their way into the manure pit, and supply the nitrogen needed for the proper breaking down of the carbohydrate material of the dung and litter by bacterial fermentation. In India bedding is rarely used, for one reason because it is often unavailable, straw being of more value as fodder, and secondly because it is only rarely needed to provide warmth for the cattle. The urine may be absorbed by soil spread over the floor of the cattle shed, but this practice is not very common and generally the urine is allowed to run to waste. Thus cattle dung is the chief and almost only constituent of Indian farmyard manure, and investigations carried out on dung are of more immediate importance than those on mixtures of dung with urine and litter. Joshi [1922] has shown that there are greater losses of nitrogen when dung and urine are mixed than when they are stored separately, and he has dealt with the problem of the conservation of nitrogen in stored urine. In this investigation we confine ourselves to problems connected with the stored dung.

Ever since the discovery of the utility of farmyard manure, numerous attempts have been made in various parts of the world to find out suitable methods for its storage. It was observed that during fermentation the farmyard manure lost some of its very valuable constituents. Attempts to minimise these losses resulted in suggesting its storage under cover, to protect from the action of rains, and to keep it moist and consolidated. Later on the use of preservatives, such as superphosphate, kainit, gypsum, chalk, formalin, etc., was advocated.

In India some of the above methods were tested, found satisfactory, and recommendations for its storage under cover in moist consolidated conditions were

frequently made. Keeping it covered with soil also found favour with some investigators but very little attempt has been made to test the possibilities of using preservatives. Only Joshi [1922] has published an account on the use of preservatives for this purpose in one of the important publications in India. Joshi [1922], during the course of his studies on the control of losses of nitrogen from urine, found that none of the materials, such as gypsum, calcium chloride, kainit and potassium salts, proved efficient. Formalin, sulphuric acid and superphosphate gave encouraging results but the quantities used proved prohibitive from the economic point of view.

Since the value of dung depends on its dry matter and its nitrogen content and these suffer the greatest losses during storage, only these constituents were taken into account in the study of this problem.

In selecting the preservative the choice fell on superphosphate because, besides being an efficient preservative, it supplies phosphoric acid to soil. Its preservative efficiency, compared with that of other materials has been reported on by Ames and Richmond [1917], Collison and Conn [1922] and many others. Ames and Richmond [1917] found it superior to calcium sulphate or sulphur in retaining nitrogen. Collison and Conn [1922] used rock phosphate, acid phosphate, gypsum, peat, and straw, and found acid phosphate the best preservative for both dry matter and nitrogen ; peat was good, rock phosphate was poor and gypsum showed indifference.

The next point after the selection of the preservative was the consideration of the amount to be used to make it economically effective. The normal dressing of cattle dung for ordinary crops is five tons, and for garden crops it is about ten tons per acre. If this were to be treated with one per cent. or two per cent. superphosphate, the amount of phosphate would come to one to two cwt. per acre with five tons and two to four cwt. with ten tons of manure, and so these amounts were used.

The results of the experiment have shown that since poor dung needs only one per cent., the amount of superphosphate per acre even with ten tons of manure would come to only two cwt. per acre. With rich dung, which was one and a half times richer than the poor dung in its nitrogen content, two per cent. superphosphate was more effective than one per cent. With ten tons of this dung the amount of superphosphate would come to four cwt. per acre which is a little more than normally applied to fields, but in view of the fact that only six to seven tons of rich dung are equivalent to ten tons of poor dung for application to the fields, the amount of superphosphate will also be reduced to 2·4 to 2·8 cwt. per acre.

## Experimental details.

In the early morning on the 1st of December, 1928, about a maund of dung free from litter and urine was collected from the bullock-shed at the farm. The

sample represented the dung of a dozen Montgomery bullocks. Similarly another maund of dung of a dozen Montgomery cows in milk was also collected from the dairy shed. Both samples were brought to the laboratory in covered pails. Each was then thoroughly mixed on a washed cemented floor, and three lots of 4,000 grm. were weighed out from each kind of dung into wide enamelled basins. One of these lots was stored in weighed glass jars of four and a half litre capacity. To the second lot was added one per cent. and to the third two per cent. superphosphate. After thorough mixing these too were placed in similar jars. The jars were again weighed and samples were taken for analysis. They were then covered with big glass plates and left at room temperature (20° C. to 32° C.) till the 22nd October, 1929, when they were again analysed.

It may be mentioned here that during the week preceding the date of taking the samples all the cattle received maize silage and oat *bhusa* as dry fodder and crushed oats and oil-cakes as concentrates. As green fodder the bullocks received a little green cow-pea and *meth* (*Phascolus aconitifolius*), while the cows had free access to berseem in fields. In concentrates, the cows' diet differed from the bullocks' in having crushed pulses instead of crushed maize, in addition to the crushed oats and cake mentioned above.

## ANALYTICAL METHODS.

*Moisture.* Fifty grm. of dung composts were weighed out in a flat-bottomed porcelain dish and dried at 65° C. to a constant weight.

*Total nitrogen.* This was estimated by the Kjeldahl-Gunning method. To avoid smearing of the neck of the digestion flasks, the samples were weighed out on weighed pieces of paper, which were then rolled and dropped into flasks. Quadruplicate analyses were made in each case with samples weighing between 19 to 20 grm.

*Ammonia.* Ten grm. of dung composts were transferred to distillation flasks with 500 c.c. of distilled water and the ammonia was distilled with freshly ignited magnesia into standard acid. For this, duplicate smaples were taken but where they failed to agree, duplicate samples were again taken and the averages of three agreeing determinations were recorded.

All the calculations at start have been recorded on the contents of the jars after deducting the amounts used for analysis. It will be noticed from the results that the composts treated with superphosphate show an increase in their nitrogen content. This is due to the presence of 0·57 per cent. nitrogen in the superphosphate itself. A little variation, of course, will have to be attributed to experimental error.

## Results and discussions.

### LOSS OF DRY MATTER.

TABLE I.

*Effect of superphosphate on the loss of dry matter of dung during its fermentation.*

| Kind of compost | Dry matter per jar at start (1st December, 1928) | Dry matter per jar after fermentation (22nd October, 1929) | LOSS OF DRY MATTER | |
|---|---|---|---|---|
| | | | Per jar | Per cent. |
| | Grm. | Grm. | Grm. | |
| Bullock dung . . . . . . . | 593·67 | 405·75 | 187·92 | 31·65 |
| „ „ + 1 per cent. super . . | 620·89 | 492·98 | 127·91 | 20·60 |
| „ „ + 2 per cent. super . . | 650·92 | 539·73 | 111·19 | 17·08 |
| Cow dung . . . . . . . | 626·13 | 403·46 | 222·67 | 35·56 |
| „ „ + 1 per cent. super . . . | 641·98 | 479·08 | 162·90 | 25·46 |
| „ „ + 2 per cent. super . . . | 666·70 | 560·29 | 106·41 | 15·96 |

That the dung during storage loses some of its dry matter is a universally admitted fact, but the extent of loss is, however, controllable and varies with the method of storage. From the examination of Table I, it will be seen that other factors being the same, the loss is also dependent on the quality of the dung, which in its turn depends on the kind of food given to the cattle. In the cow dung, which was rich in nitrogen, the loss came to 35·56 per cent. against 31·65 per cent. in the dung of bullocks, poor in nitrogen. These results may be compared with those of Wood [1907], who found that the dung of cattle fed on roots, hay, and cake lost 18·6 per cent. of its dry matter in six months against 16·2 per cent., lost by the dung of cattle fed on roots and hay only.

Further examination of Table I reveals that this loss is controllable to a great extent if superphosphate is added to the fresh dung before storage. With one per cent. superphosphate the loss of dry matter in the poor dung of bullocks has been reduced from 31·65 per cent. to 20·60 per cent. in the control. The corresponding figures in the rich dung of cows come to 35·56 and 25·46 per cent. With two per cent. superphosphate the losses have been further reduced to 17·08 per cent. and 15·96 per cent. in poor and rich dung, respectively.

TABLE II.

*Amount of dry matter retained by treatment with superphosphate out of that lost in the controls per 100 grm. of dry matter.*

| Kind of compost | Dry matter lost | Dry matter retained from that lost in the controls | |
|---|---|---|---|
| | Per cent. | Grm. | Per cent. |
| Bullock dung | 31·65 | .. | .. |
| " " + 1 per cent. super. | 20·60 | 11·05 | 34·90 |
| " " + 2 per cent. super. | 17·08 | 14·57 | 46·00 |
| Cow dung | 35·56 | .. | .. |
| " " + 1 per cent. super | 25·46 | 10·10 | 28·40 |
| " " + 2 per cent. super | 15·96 | 19·60 | 55·10 |

When calculated on the basis of the actual amount of dry matter retained to that lost in the controls, it will be seen from the above table that in the case of poor dung one per cent. superphosphate retained 34·90 per cent., while two per cent. retained it to the extent of 46 per cent. With rich dung the figures of retention came to 28·40 per cent. and 55·1 per cent. for one and two per cent. superphosphate respectively.

These figures thus show that, for the control of loss of dry matter in dung, the addition of one per cent. superphosphate gives satisfactory results with poor dung, but with rich dung two per cent. is essential.

These results compare well with those of Ames and Richmond [1917], Collison and Conn [1922], Dietzell [1897] and Pfeiffer [1897].

In Ames and Richmonds' experiments [1917] with horse dung and 2·5 per cent. acid phosphate, the loss came to 21·78 per cent. against 32·5 per cent. in the control in eight months. Collison and Conn [1922] after four months' fermentation of the horse dung with one-fourth of its weight of urine lost 63·4 per cent. of its dry matter, but by treatment with 5 per cent. acid phosphate they were able to reduce the loss to 25 per cent. only. Dietzell [1897] conducted the experiment with cow dung with 10 per cent. chopped straw. Under aerobic condition he found the loss of dry matter up to 45·93 per cent., which with superphosphate came to 39·49 per cent. only in about six months. Pfeiffer [1897] found a loss of 24·34 per cent. in consolidated untreated dung against 16·92 per cent. in the dung treated with superphosphate in about five months.

## Loss of Nitrogen.

### Table III.

*Effect of Superphosphate on the loss of Nitrogen in dung during its storage.*

| Kind of compost | Total N per jar at start (1st December, 1928) | Total N per jar after fermentation (22nd October, 1929) | Nitrogen lost | |
|---|---|---|---|---|
| | | | Per jar | Per cent. |
| | Grm. | Grm. | Grm. | |
| Bullock dung | 8·577 | 7·797 | 0·780 | 9·10 |
| „ „ + 1 per cent. super | 8·853 | 8·378 | 0·475 | 5·37 |
| „ „ + 2 per cent. super | 9·330 | 8·947 | 0·383 | 3·85 |
| Cow dung | 13·056 | 9·671 | 3·385 | 25·92 |
| „ „ + 1 per cent. super | 13·503 | 11·994 | 1·609 | 11·91 |
| „ „ + 2 per cent. super | 13·677 | 12·714 | 0·963 | 7·04 |

At the very first sight it will be seen from Table III that the dung lost some of its nitrogen during storage. That this loss is unavoidable, has been observed by many workers. Only in rare cases it has been observed that the whole of the nitrogen of the original dung has been recovered after fermentation. Russell and Richards [1917] found no loss only in one of the compacted heaps, while in all others loss did occur. Berry [1909] also showed that the manure kept covered with soil lost none of its nitrogen but these appear to be exceptional, uneconomical and impracticable cases, as the dung heaps to which fresh dung is added every day can neither be conveniently compacted daily, nor can they be covered daily with a thick layer of soil. Besides this, considerable loss of nitrogen even in well-compacted dung heaps has been observed by Berry [1909], Wood [1907], Goodwin and Russell [1905] and Russell and Richards [1917] and others.

Table III further shows that the rich dung lost more nitrogen than the poor dung. The former lost 25·92 per cent. against 9·1 per cent. lost by the latter. These results agree with those of Wood [1907] who found that the dung of animals fed with roots and hay lost 10·6 per cent. against 26·9 per cent. in the dung of animals fed on roots, hay and cake. Goodwin and Russell's observations [1905] also confirm these results.

Now the problem naturally arises as to how to put a check to the waste of this most valuable fertilizing element. The present experiment shows that the addi-

tion of superphosphate to the fresh dung before storage minimises this loss to a considerable extent though it does not stop it completely. With one and two per cent. superphosphate, the losses have been reduced to 5·37 per cent. and 3·85 per cent. from 9·1 per cent. in the poor dung, and to 11·91 per cent. and 7·04 per cent. from 25·92 per cent. in the rich dung.

TABLE IV.

*Amount of nitrogen retained by treatment with superphosphate out of that lost in the controls per 100 grm. of nitrogen.*

| Kind of compost | Nitrogen lost | Nitrogen retained from that lost in the controls | |
|---|---|---|---|
| | Per cent. | Grm. | Per cent |
| Bullock dung . . . . . . . . . . . | 9·10 | .. | .. |
| „ „ + 1 per cent. super. . . . . . | 5·37 | 3·73 | 40·99 |
| „ „ + 2 per cent. super. . . . . . | 3·85 | 5·25 | 57·69 |
| Cow dung . . . . . . . . . . . | 25·92 | .. | .. |
| „ „ + 1 per cent. super . . . . . . | 11·91 | 14·01 | 54·04 |
| „ „ + 2 per cent. super . . . . . . | 7·04 | 18·88 | 72·07 |

Calculated in terms of retention of nitrogen out of that lost in the controls, Table IV shows that one per cent. superphosphate retained 40·99 per cent. in poor dung and 54·04 per cent. in the rich dung, while two per cent. retained 57·69 per cent. and 72·07 per cent. in poor and rich dung, respectively. Here again, just as in the case of dry matter, these figures show that for rich dung two per cent. superphosphate should be used, while for poor dung one per cent. may be enough.

That these figures concur with those of other workers will be seen from the following summary :—

Dietzell [1897], by treatment with superphosphate, was able to reduce the loss of nitrogen from 9·08 in the control to 5·48 per cent. in the treated dung. Pfeiffer [1897] in untreated compacted dung lost 49·7 per cent. against 33·56 per cent. in that treated with superphosphate. Ames and Richmond [1897] by treatment of horse dung brought down the loss of nitrogen to 3·1 per cent. from 10·6 per cent. in the control. In Collison and Conn's experiments [1922] superphosphate was able to reduce it to 20·3 per cent. from 50·8 per cent. in the control.

All these experiments show that superphosphate when added to dung plays an important part in preventing the loss of dry matter and nitrogen, and that the

amount to be added depends on the quality of dung. For the dung of those cattle who maintain their lives on rough fodders only, one per cent. superphosphate will be more than enough, but where the cattle get rich concentrates two per cent. should be used.

**Relation of ammoniacal nitrogen with total nitrogen in the dung treated with superphosphate.**

During storage the complex protein compounds of the dung undergo decomposition, and the nitrogen is converted into free nitrogen and ammonia. Of these forms, the free nitrogen returns to the atmosphere. A little ammonia too is volatilised and is lost, but the major portion of it finds its way into the fields to which the dung is applied, where, for crops like paddy grown in standing water, it serves directly as a plant food, and in aerated soil it is subjected to the action of certain bacteria which convert it into nitrates to be used by the plants. Under these conditions the aim of every cultivator should be to ferment his farmyard manure in such a way that a high proportion of its nitrogen may be transformed into the ammoniacal form in the heap and yet be not lost by volatilisation. Both of these conditions are fulfilled by treatment of the dung with superphosphate, as will be seen from the following table.

TABLE V.

*Effect of superphosphate on the conversion of total nitrogen into ammoniacal nitrogen in fermenting dung composts.*

| Kind of compost. | Total nitrogen per jar at start | AMMONIACAL NITROGEN | | PER CENT. OF ORIGINAL NITROGEN FOUND AS AMMONIA | |
|---|---|---|---|---|---|
| | | At start | After fermentation | At start | After fermentation |
| | Grm. | Grm. | Grm. | Per cent. | Per cent. |
| Bullock dung . . . | 8·577 | 0·713 | 0·564 | 8·31 | 6·58 |
| Bullock dung + 1 per cent. super. | 8·853 | 0·840 | 1·140 | 9·49 | 13·36 |
| Bullock dung + 2 per cent. super. | 9·330 | 1·045 | 1·382 | 11·79 | 15·47 |
| Cow dung . . . . | 13·056 | 0·908 | 1·114 | 6·95 | 8·53 |
| ,, ,, + 1 per cent. super | 13·503 | 1·113 | 3·251 | 8·24 | 24·08 |
| ,, ,, + 2 per cent. super | 13·677 | 1·223 | 4·080 | 8·94 | 29·81 |

The above table shows that poor dung stored without any treatment lost some of its original ammoniacal nitrogen, while it has increased in the rich dung. In the former it has come down to 6·58 per cent. from 8·31 per cent., and in the latter it has gone up to 8·53 per cent. from 6·95 per cent. With the addition of superphosphate to the poor dung the ammoniacal nitrogen has been increased by one and a half times that of the original ammoniacal nitrogen and by three times in the rich dung. In poor dung 13·36 per cent. and 15·47 per cent. of the original total nitrogen appeared in ammoniacal form after fermentation, while in the rich dung it has gone up to 24·08 per cent. and 29·81 per cent. with one and two per cent. superphosphate respectively.

To adopt the method on a practical basis approximately the required amount of superphosphate should be scattered over each day's dung as soon as it is transferred to the manure pit.

## Summary and conclusions.

The paper deals with the investigation concerning the loss of dry matter and nitrogen transformations in the cattle dung during its storage. For this purpose bullock dung and cow dung were stored separately, with and without treatment with superphosphate, for ten months under laboratory conditions. The cow dung was one and a half times richer than the bullock dung in its nitrogen content. The composts were analysed in the beginning and at the end of the period of observation for dry matter, total nitrogen and ammoniacal nitrogen. From the results of analyses the following conclusions have been arrived at :—

1. The rich dung loses more of its dry matter than the poor dung during storage. The former lost 35·56 per cent. against 31·56 per cent. by the latter.
2. The addition of superphosphate to the dung before storage reduces this loss to a considerable extent.
3. For the poor dung the addition of one per cent. superphosphate is enough, but for the rich dung two per cent. is essential. One per cent. retained 34·9 per cent. of the dry matter lost from the poor dung against 28·4 per cent. in the rich dung. With two per cent., the corresponding amounts came to 46·0 per cent. and 55·1 per cent., respectively.
4. Loss of nitrogen is greater in the rich dung than in the poor dung. The latter lost only 9·1 per cent., while the former lost 25·92 per cent.
5. Superphosphate is efficacious in minimising this loss to a great extent. Of the nitrogen lost in the controls one per cent. superphosphate was able to retain 40·99 per cent. in the poor dung and 54·04 per cent. in the rich dung, and the two per cent. retained 57·69 per cent. and 72·07 per cent. in the poor and the rich dung, respectively.

6. The richer the dung in nitrogen, the more superphosphate may be added, but keeping in view a normal dressing of two to three cwt. of superphosphate per acre, more than two per cent. should not be added.
7. Superphosphate is not only effective in controlling the loss of dry matter and nitrogen, but it increases the conversion of total nitrogen into ammoniacal form and is able to retain it in that form. This production of ammonia is more vigorous in the rich dung than in the poor dung. In the poor dung treated with superphosphate the original ammoniacal nitrogen was increased by one and a half, and in the rich dung by three times.

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# A SHORT NOTE ON THE DISEASES OF COTTON SEEDLINGS IN THE CENTRAL PROVINCES.

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In the Central Provinces, cotton plants are susceptible to many diseases, particularly in the seedling stage; at times the mortality is so heavy that resowing is essential. Though seedlings die annually, the loss is very heavy in unfavourable seasons; this loss of seedlings, however. passes unnoticed in favourable seasons, owing to the general practice of very heavy seeding. It had been in the past taken for granted that the cause of the death of seedlings was due to " wilt ", to which some varieties, like Roseum, are specially susceptible. The writer of this note was also guilty of the same assumption when he first commenced the study of cotton wilt in 1924.

As the study of the wilt disease progressed, it was noted that this disease was chiefly confined to plants that had passed the herbaceous stage and had developed woody stems. As a rule cotton plants were susceptible to this disease after they were about two months old. All varieties of cotton were not equally susceptible to wilt; some, like Roseum, were highly susceptible whereas varieties like Buri were wholly resistant. But in the seedling stage when the stem was still soft and succulent many plants died of disease, and they showed none of the typical symptoms of wilt. The seedling diseases, unlike wilt, were not confined to any particular variety. Wilt-resistant varieties were also highly susceptible to these seedling disease. It was further found that the seedling diseases were caused by more than one organism. There are evidently two distinct types of seedling diseases—(1) a wet-rot or " damping-off " and (2) a dry-rot.

*Wet-rot or " damping-off ".* The infected seedlings damp off. The collar is soft and rotten and at times constricted. The stem does not remain erect but falls over at or near the surface of the ground. The underground parts are, more or less, completely decayed and are water-soaked; the diseased seedlings, therefore, cannot be uprooted intact. The damping-off is caused by two members of the *Phycomycetes*; one is a *Pythium* and the other a *Phytophthora.* This damping-off disease is capable of infection only in very humid conditions or when the soil is water-logged at the time the seedlings are not more than two to three weeks old; the loss of seedlings from damping-off is therefore not serious. One of the causes of the apparent non-germination of cotton seeds, *i.e.*, the non-appearance of plants above the ground surface, is infection of the sprouting seed by these Phycomycetous fungi and the consequent death of the seedlings before they can break through the soil surface.

*Dry-rot.* This disease, caused by *Rhizoctonia bataticola* (Taub.) Butl. and known as sore-shin, is easily distinguished from the damping-off disease; the stems of infected plants stand upright and the diseased part is not water-soaked. The infected plant can be easily uprooted, with the tap-root intact. The disease infects both the collar, or the underground part of the seedling, and the leaves. It is fatal only when the collar or the underground parts are infected. If a dead or dying plant is removed from the ground, the collar is found to be discoloured. It is at first pale brown or reddish brown, which later turns dark brown, and ultimately it is almost black. The infected part of the tap-root is thinner than the healthy parts above and below it, as it has shrunk due to the drying up of the cortical tissues. This is particularly the case when the diseased seedling is very young and the tap-root and stem are succulent. If the stem of the young plant has become woody, the constriction of the infected part may not be conspicuous, but the diseased bark is in shreds.

The infected leaves have a very characteristic appearance and are easily distinguished from the drooping leaves of a wilt-affected plant. If the cotyledons are slightly affected, they look as if they were badly pinched between the thumb and the fore-finger. They do not lose their green colour and do not turn yellow. When practically the whole of the cotyledon is diseased, it is shrunken and looks smaller in size and hangs limply; very often only one cotyledon is diseased. The foliage leaves when infected do not at first wholly lose their green colour, but they look as if they were being bleached. At a later stage they turn brown. The infected leaves lose their water contents and so look shrunken and crumpled. They have a tendency to roll inwards from the tip towards the petiole. They are crisp and dry to the touch and can be easily crushed to bits. The infection remains confined to the diseased leaf. It does not spread to the stem from the leaf and, therefore, when only the leaves are affected there is no general loss of turgidity. These infected leaves are ultimately shed and the plants put forth new shoots and buds. But when the collar or the tap-root is infected, the infection is fatal.

As a rule the disease is confined to seedlings and young plants. They are liable to infection even before the primary leaves have emerged from the seed-coat, and thus poor germination may be due not to bad seeds, but to infection by this disease. Plants less than 10 to 12 weeks old are usually most susceptible to this disease. Mature plants, as a rule, do not get infected but they are not wholly immune. In Nagpur, in 1927, in one field plants about three to four months old were found infected by this disease, which was confined only to leaves. The infection did not spread from the leaves to the stem or tap-root, and so the plants were not killed. The disease was observed from about three or four weeks. The plants were at first defoliated but they put forth new leaves, and ultimately there were no signs of the disease. This year a root-rot of mature cotton plants has been reported from many localities in these provinces. This root-rot has caused in some places considerable damage. *Rhizoctonia bataticola* has been isolated from the infected tap-roots.

For many years attempts have been made to reproduce the disease by inoculations. The inoculations were done in several ways, *e.g.*, the soil was well mixed with the fungus (*R. bataticola*) a few days before sowing and kept moist for the fungus to establish itself in the soil; the soil was mixed with the fungus at the time of sowing; the seed was coated with the fungus before sowing; seedlings were inoculated at the collar when they were a few days old; but the inoculations always gave negative results. Though the inoculations on leaves were always successful, the infection was confined to the leaf inoculated, which dropped off as in the case of naturally infected leaves, without the infection spreading to the stem.

It has now been found that the fungus is capable of infection only under certain limited soil conditions. Any cause that delays the germination of the seed—by germination is meant the appearance of the cotyledons above the soil surface—is favourable for the infection of the seedling. This delayed emergence of the primary leaves above the soil surface may be due to many causes. A certain number of seeds, even under the best germinating conditions, sprout more slowly than other seeds out of the same lot. It is these slow developing seedlings which are susceptible to this disease. This has been found not only experimentally but from observations made in many infected fields; in fields where conditions for seed germination have been favourable it has been observed that a large majority of the infected seedlings are those which are much smaller than their neighbours. These plants are not dwarfed but are only smaller in size as the seedlings burst through the ground surface later than their neighbours. The cause of this delayed germination is physiological and, therefore, there is not much loss in fields where the conditions for germination of seeds have not been adverse. But when the soil conditions have been unfavourable to quick germination, there is a heavy loss of seedlings, at times amounting to 30 per cent. The adverse soil conditions are brought about by many causes. For example, if seeds are sown when the soil is just sufficiently moist, after the first few showers of rain, to help the seed to begin to sprout, and if there is a long break after the sowing, the cotyledons do not come out through the soil surface in four or five days after sowing, but take a longer time; again there may be sufficient soil moisture to ensure normal sprouting of the seed but the top surface may be packed too tight for the seedling to emerge without delay. After sowing the seed under favourable soil conditions there may be a heavy fall of rain so as to completely flood the fields. In these flooded fields, in which water has been standing for some hours, if not days, the top surface forms a hard crust on drying, which the seedlings underground cannot readily break through. Under these conditions the seedlings are in a critical stage for infection, and there is usually a heavy incidence of the disease. Successful inoculations have been obtained when such conditions were re-produced in pots. Field observations as well have shown that seedlings are susceptible to dry-rot when soil conditions are unfavourable for rapid germination. This year reports have been received from many places regarding the high rate of mortality of seedlings. Wherever a detailed examination has

been made, it has been found that the greatest damage has occurred in those fields which were sown early, immediately after the first break of the monsoon ; a couple of days after sowing there was a heavy rainfall which completely flooded the fields ; water was standing in the fields for some time after the rain had fallen ; as a result, on drying. a hard crust was formed on the surface ; in these fields germination was naturally delayed and there was a large number of diseased plants ; whereas in those fields which were sown after the heavy fall of rain that is, a fortnight or so after the first sowing was commenced, there was very little disease. The late sown fields had a better stand of cotton plants than the early sown fields. In the former not only were there a larger number of plants, but the plants were bigger in size and more luxuriant in growth.

Thus field observations have confirmed laboratory experiments.

Having found the conditions under which the dry-rot of cotton seedlings does most damage, some suggestions can be made for its prevention. It is essential that the germination must be rapid, and therefore the soil must be in a condition to ensure quick growth of the seedlings. In infected fields seeds should not be sown very early, unless there has been sufficient rainfall so that the soil moisture is enough for quick germination of the seed. If, after sowing, the fields are flooded and a hard crust has been formed on the surface on drying, steps should be taken to break the crust as soon as possible so as to help the seedlings to emerge above the ground surface.

This disease, as already stated, is chiefly a disease of seedlings, but mature plants have also been found to be susceptible. The disease does most damage to mature plants when grown in water-logged fields. In fields which are uneven, plants growing in hollows of the field are usually affected especially after a heavy rainfall. The badly affected plants have the bark at the collar in shreds and the wood is discoloured brown to black. In early stages of the disease, the bark of the tap root and the collar is intact but is discoloured brown. Unlike the seedling blight, there is no shrinking of the affected parts. Mature plants are liable to infection by this disease under the following conditions as well. If, after a heavy fall of rain, the wet soil dries very rapidly as a result of the weather clearing up and the temperature rising suddenly, it forms a hard cake round the collar of the plants and presses tightly against the collar, which consequently loses its cylindrical form and gets flattened out. The bark of the flattened parts breaks up into longitudinal cracks, through which *Rhizoctonia* infection takes place and the plant is ultimately killed. Infection is also known to occur through wounds caused by insects and agricultural implements at the time of weeding and hoeing. However, there have been cases in which the infected dead or dying plants show no external signs of injury. It is not known how the infection in these cases takes place.

The disease on the leaves, as already stated, is not fatal. The infection from leaf to leaf is carried by healthy leaves coming in close contact with a diseased

leaf. This often happens when in a shower of rain healthy leaves get stuck to a diseased leaf by means of a film of water between them.

Spiders have been observed to carry the infection from leaf to leaf. When a spider spins its web joining a diseased leaf with a healthy leaf, it has been noted that the latter shows signs of infection in a couple of days.

*Rhizoctonia bataticola* (Taub.) Butl. has invariably been isolated from diseased leaves. It has extremely minute, black sclerotia, not bigger than a pin head. From diseased tap-roots and collars of seedlings this fungus is chiefly isolated, but in some cases *Rhizoctonia solani* Kunz., having big, brown, irregularly shaped sclerotia, has been obtained ; both these fungi have been found to be parasitic to seedlings under the conditions described above ; no morphological differences can be detected in the symptoms produced by these two *Rhizoctonias* on the infected seedlings ; from mature diseased plants only *Rhizoctonia bataticola* (Taub.) Butl. has been obtained.

# SELECTED ARTICLES

## RINGING FRUIT TREES : THE PRESENT POSITION.*

BY

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(*Technical Communication from the Imperial Bureau of Fruit Production, East Malling Research Station. May 1930.*)

Although ringing has been practised for many hundreds of years, the resulting phenomena have not yet all been satisfactorily explained. When once the exact physiological effects under varying conditions have been determined, horticultural experts will be in a better position to give advice as to the value and desirability of ringing under any given circumstances.

### AIM.

At present there is no definite agreement even as to the aim of the practice. While it is generally accepted that ringing will under certain conditions cause the formation of fruit buds in hard fruits with a consequent production of fruit in the following year, considerable disagreement exists as to its effects on the set of blossom in the year of ringing.

Thus Gourley and Howlett[23]† do not consider that it affects the set of fruit. Swarbrick[54], moreover, notes that the factors controlling the set of apple blossoms are quite different from those governing their formation, and that, where there is a regular show of blossom but no set of fruit, it is not advisable to ring the trees.

Seabrook,[48] on the other hand, writes :—" Ringing appears to provide the flowers with enough material to develop fruit". Heinicke[27], again, notes that in his experiments on apples " ringing has invariably increased the set of fruit". Certain other minor experiments in this country of recent years have also, without proving the fact, given good grounds for supposing such to be the case.

That ringing causes the set of fruit in grape vines has been satisfactorily proved by Perold[47], and others[1];[41] and this is the main object of the practice in viticulture, where it is a most usual treatment in the cultivation of table grapes. Whether it also induces early ripening of the grapes, as is claimed by some[7], is not so certain.

* This summary of the present position of knowledge on the ringing of fruit trees is published by kind permission of the Director, Imperial Bureau of Fruit Production.

† Reference by superior figures is to the literature cited at the end of the article.

In dealing with the hard fruits, however, its more usual object, at any rate, is the formation of flower-buds or as stated by Swarbrick[54] " the bringing of unproductive, over-vegetative trees into a condition of fruitfulness. The practice will be governed by the principle, that in the case of over-vegetative trees any practice that will slow down growth will be conducive to flower bud formation".

## Forms of Ringing.

Gourley and Howlett[23] describe the immediate object to be the production of a temporary cessation in the downward translocation of plant food without permanent injury to the tree.

This object may be attained by several methods no one of which has as yet been proved of definite superiority.

Thus :—Cutting out a circular ring of bark—twisting a wire tightly about the branch or trunk—drawing a sharp blade around the limb or trunk without removing a section of bark (known as " scoring " or " knife edging ")—and such accidental injuries as the killing of the bark by fire, disease or the gnawing of animals all give the effect of ringing.

The narrow ring method is that advocated by Swarbrick[57]. He prefers to use an ordinary sharp pruning knife. With this he makes a narrow, complete ring, which is about ½" wide on trunks of 4-6" diameter and somewhat less on trunks of smaller girth. The depth of the ring is, of course, down to but exclusive of the xylem. The ring is covered with a few rounds of surgical adhesive tape or electrical insulating tape. Neither grafting wax nor any other substance, which might flow into the ring and prevent the fusion of the callus from the two edges of the ring, is used for covering purposes. The tape may be removed when the ring is completely filled with callus tissue, generally in about a month or six weeks' time. A sufficient check to growth is thus obtained to ensure flower-bud formation, and at the same time there is no danger from open wounds. The process, a very simple one, can be repeated when and if necessary.

Other methods are the removal of a spiral ring of bark and of incomplete rings. In the latter case either parts of the bark are removed, leaving bridges between, or such a system is employed, as has been practised for the last few years with considerable success in the Wisbech area. It has been called the " Gardner " method from the fact that Messrs. Gardner have invented a three edged knife which greatly facilitates the operation.

## " Gardner " method.

This method consists of the removal of two half rings of bark about ⅜" wide, at about 4" apart on opposite sides of the stem. In obstinate cases of non-fruiting the rings are made to overlap. These rings are kept open and are protected from the

entry of fungus spores and woolly aphis by white lead paint or other similar substances.

It is as yet too soon to say whether this method is, under Wisbech conditions, more free from harmful after-effects to the ringed trees than any other method.

### Knife edging.

Knife edging has been successfully used by Lees[34] in this country in order to shape the growth of young trees and seems to offer considerable commercial possibilities.

He combined his system of knife edging with very close summer and winter pruning in order both to build trees into the shape required, and to encourage fruiting.

It was found that knife edging caused the production of lateral branches immediately below the wound and that it was so possible to get rows of pyramidal cordons, entirely self-supporting and flowering profusely every year.

### Time of Ringing.

Swarbrick[56] in his account of experiments to determine some of the physiological effects of ringing, notes that " the date of ringing markedly altered the responses produced".

Gourley and Howlett[23] note that the operation should take place at a time when the wound will heal rapidly and prior to the time of fruit bud differentiation.

Seabrook[49] recommends ringing just before, during and just after flowering time, beginning as soon as the bark " runs " freely.

Swarbrick[57] considers that the proper time for ringing is best defined by the blossoming period, and that ringing should be carried out within 14-21 days after the petals begin to fall, or any time from full bloom to 14 days after petal fall. He does not recommend ringing earlier, while he notes that ringing later often fails to induce flower-bud formation in the same year, while the " hold over " effect to the following year may not be enough to induce it then, so that the result is negligible.

He[54] notes that in this country the best opportunity will probably occur some time in May or early June. His observations confirm those of Barker and Lees[4] who, in their account of earlier work at Long Ashton, report as follows :—

" The later the rings are made, the less will dormant buds below be stimulated. This conclusion is strengthened by some rings made elsewhere in June, when an intermediate result was obtained (*i.e.*, to those got from May and July ringing).

The operation in July is dangerous owing to the risk of canker.

Ringing in May causes growth in buds that would otherwise remain quiescent. the effect being most marked immediately below the ring, though there is at the same time a tendency for the stimulus to be accentuated at the base of the twig.

The experiments indicated that callus grew more slowly in July than in May. Despite this, however, less effect was produced on bare wood below in July than in May after ringing."

Shaw[51] observing the effect of ringing on apple trees in Massachusetts also stresses the necessity for choosing the proper time and adds the following warning :—" Ringing similar trees in midsummer not only fails to stimulate fruit-bud formation, but may seriously weaken the tree and inhibit both growth and fruit production."

PHYSIOLOGICAL EFFECTS.

Although absence of absolute knowledge of the exact function of the vessels of the phloem and of the outer wood under all circumstances precludes certainty on this point at present, the proper application of ringing must eventually be based on a more certain knowledge of the movement of assimilated foods in the stem.

With slight variations the views of Kains, which are actually quoted by Barker and Lees[4], may be taken as representative of the views of most workers in this field :—

" The theory of the operation is that the removal of a band of bark through the cortex and phloem of a plant, at the period of most vigorous growth, does not hinder the upward passage from the roots to the leaves of unassimilated sap through the outer layers of woody cells, but does prevent the distribution, through the vessels in the cortex and inner bark below the wound, of assimilated food. The effect of this action is to cause an extra amount of reserve material to be stored in the upper parts of the plant for the production of fruit buds."

Kains explains the appearance of sprouts below the wound as the endeavour of nature to provide assimilated food for the roots, owing to the passage of such food for the roots from the upper portion of the tree being cut off.

Chandler[8] referring to its effect of the set of fruit writes as follows :—

" Ringing increases the amount of carbohydrates relative to nitrogen. Ringing may have other influences. There is the possibility that fruit setting is influenced by some organic nitrogenous compound ; that ringing, by preventing this from moving backward, increases the amount available for the young fruit."

Swarbrick[55] does not appear to be entirely satisfied with the present state of knowledge and writes as follows :—

" It is probable that in both ringing and defoliation, while the question of food is undoubtedly involved, we shall have to look into the more deeply seated physiological changes, particularly those that re-act upon the growing meristem cells of the cambium.

In view of the production of almost similar types of cells as the result of both defoliation and ringing, it is obvious that we must look for some common factor that could be regarded as causal.

It seems probable that the explanation will be found in a change in the nature and reaction of the fluids moving in the plant tissues such as Pearsall and Priestley[46] suggest."

In the last ten years considerable work has been devoted to this study by Curtis[11-15] and by Mason and Maskell.[37-40].

The former[12] concludes from experiments on Apple, *Ligustrum ovalifolium* and *Philadelphus pubescens*, that in all probability there is normally no upward movement from the roots of foods stored in the roots and perhaps little or none from the main trunk.

In 1922 he[13] showed the effects of ringing on the upward transfer of nitrogen and ash constituents in the case of privet, peach and lilac. He found that a ring distinctly hinders the movement of nitrogen and ash constituents into the leaves above the ring, either when this is made in the spring before the leaves open and the new xylem is laid down, or when it is made in the summer after they have opened and the new xylem is partly or fully formed. He notes the possibility that the xylem tissues were injured by the treatments given and so prevented from carrying nutrients—if such be their role—but, granted this possibility, his data afford strong evidence for nutrients being carried chiefly in the phloem.

Further experiments[14] published in 1925 enabled him to show that the plugging of the xylem in his earlier experiments could have been only partial and that partial plugging could not have fully accounted for the hindrance in solute movement observed.

He concludes :—" It seems that solute movement, both upward and downward, occurs chiefly through the phloem tissues, and that this is hastened by streaming movements within the living cells."

Further evidence that the upward movement is chiefly through the phloem is given by him in 1929[15], as also a clear indication that living cells take an active part in both upward and downward solute translocation.

Mason and Maskell[37-40] have been working on the exact method of transport and storage of carbohydrates and of nitrogen in the cotton plant and have found that[40] whereas downward movement of both occurs in the bark, the vertical concentration gradients in the bark of total sugars and of organic crystalloid nitrogen are in opposite directions. The movement of carbohydrate is down a gradient of total sugars, while the movement of nitrogen is against a gradient of organic crystalloid nitrogen.

That ringing may have disastrous results on the tree is well known. Thus, where complete ringing is practised, the greatest care must be taken that the wound is followed to heal and starvation is thus avoided. It is claimed for the " spiral " and " Gardner " methods that no such danger attaches to their methods. Unfortunately, despite the very great value of such experiments to commercial fruit-growing, no adequately controlled experiments have as yet been made to establish the truth of

this claim, nor to determine the comparative merits and demerits of the various systems.

### SUBJECTS FOR RINGING.

Again ringing is not applicable equally to all sorts of fruit trees.

A case for its use in table grape growing and with the pome fruits under certain circumstances has been made. But until the passage of years and controlled experiments may have proved otherwise—and Seabrook[49-50] seems to consider that this may well be—the application of ringing to the stone fruits is strongly deprecated by both English and American authorities.

Thus, Swarbrick[54], writing in 1927, says "The ringing of stone fruit is not recommended. It has almost invariably proved fatal to the tree, due no doubt to the excessive gumming which follows wounding and the extreme readiness with which these trees are attacked by wound parasitic fungi". The same authority[57] further writes :—" For plums it is better to use a thick wire twisted tightly round the limb This gives a slower response, *i.e.*, it may be 2 years before any effect is produced. Care must be taken to remove the wire in due course, else the branch will be completely girdled and will die................under most conditions there is no necessity to ring plums, but rather the reverse. Plums crop best and most consistently when they are making plenty of shoot growth. Ringing of course always affects shoot growth adversely."

Howe[28] supports this conclusion, as also Gourley and Howlett[23] for American conditions :—" It may be said that the stone fruits are not suitable subjects for ringing, because the wounds are not likely to heal satisfactorily in this climate and the need is usually more rare."

### GENERAL REVIEW.

Opinions on the practice of ringing range from that of Chandler[8] :—" Except with the grape, ringing has only small practical importance " to that of Seabrook[49] :- " Ringing appears to standardize all varieties of apples into spur-bearing habits, and, if found reliable, will remove most of the natural disparities peculiar to most varieties. The practice, at the moment, appears likely to revolutionise apple growing in this country, if no unforeseen harmful effects appear."

Swarbrick[54] giving advice in the light of his experiments and observations writes :—

" Ringing is but a temporary measure and in this sense has but limited application.

In the case of permanent trees ringing should not be practised, unless sound cultural methods have failed to put the trees on a more permanent basis of fruiting

capacity. Before attempting ringing on a large scale it is advisable either to carry out a preliminary trial on a small scale or to obtain advice from the nearest horticultural research Station." In short, ringing should only be practised under exceptional circumstances and with a careful watch against evil consequences.

Ringing is not suitable for forcing trees which are bearing normal amounts of fruit into excessive bearing, nor does it seem likely that its effect will be the same in the case of different varieties on seedling rootstocks, but it is certainly worth a trial given such conditions as obtain in the Wisbech area in England, a very rich soil, and apples showing great vegetative growth at the expense of fruit production.

It is possible that the necessity for ringing may in the future be obviated by the adoption of such other practices as may ensure undelayed fruit formation under varying conditions of soil, etc. The standardization of rootstock material springs to the mind in this connection. Until such time, however, ringing in skilled hands may under certain given circumstances serve a most useful purpose.

The writer wishes to thank Dr. T. Swarbrick for his much appreciated help in compiling these notes.

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# INSECTS IN RELATION TO POTATO VIRUS DISEASES.

BY

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During the last decade, the attention of both plant and animal-pathologists has been attracted by the steadily increasing importance of a group of diseases, of unknown cause, which are referred to loosely as "virus diseases." These disorders attack a wide range of plants and animals, not excluding man; and they exhibit a number of points in common, justifying their inclusion in a group by themselves.

## Nature of Virus Diseases of Plants and how they differ from Bacterial or Fungal Diseases.

It will be convenient here to examine a few characteristics of these virus diseases and see how they differ from maladies of known origin due to the attacks of harmful bacteria and fungi. In 1892, Iwanowsky discovered that the juice of a tobacco plant affected with the "Mosaic" disease could be passed through a porcelain filter and still retain its power of infecting healthy tobacco plants. This capacity of the infective principle to pass through a porcelain filter, the pores of which are too small to allow the passage of the causal organisms of bacterial and fungal diseases, is one of the chief characteristics of the virus, or "filter-passing," diseases. If, then, bacteria are referred to as "the world of the infinitely small," viruses may justly be termed "the world of the infinitely smaller." It has been said above that the cause of virus diseases is as yet undiscovered. This is partly because of the difficulties inherent in dealing with an entity which is too small to be seen by the most powerful microscope, and partly because it is not possible to cultivate any virus upon artificial media outside its plant or animal host, as can be done with the majority of fungi and bacteria.

Most virus diseases are of an infectious nature and can easily be transmitted from a diseased organism to a healthy one. It is not necessary to labour this point in regard to the virus of animals that causes "foot-and-mouth" disease, the infectious nature of which is only too well known. Luckily for the agriculturist, the viruses of plants are not so easily disseminated, although they also can be very infectious to healthy plants, and may be spread rapidly in nature by methods which will be dealt with in a later paragraph. As already mentioned, viruses attack plants of all kinds, but it is in relation to the potato plant in particular that they will be considered here. The virus diseases of the potato have existed from very early times although their true nature was not recognized in those days. It has long been

known that a potato variety, if grown in one place year after year without change of "seed," gradually "degenerates" until it has to be replaced by a fresh stock or variety. It is now realized that such "degeneration" of the potato is due to contamination with one or more viruses, and not to mere continuous propagation from the same stock. There is probably no reason why a variety of potato should not be grown indefinitely from its own "seed" in one locality if the virus factor could be eliminated.

### Some Common Potato Virus Diseases.

There are several virus diseases of the potato, but only those which occur commonly, and are of economic importance, will be discussed here. The most widespread of them is undoubtedly that known as "Mosaic," the symptoms of which consist of a light and dark mottling of the leaf, sometimes accompanied by a slight puckering of the leaf-surface. The Mosaic virus is present in about 90 per cent. of the potato stocks of this country, and, in some varieties, it has become almost a varietal characteristic. A closely-allied disease, and one belonging to the "Mosaic" group, is that known as "Crinkle." Here the symptoms of Mosaic are present in an intensified form; the mottling is bolder, the leaf-surface is more puckered and the margins of the leaves are crinkled or waved. A third disease, also of the Mosaic type, is that known as "Streak"; this can be, and frequently is, of a most serious and deadly character. It resembles, perhaps, more than most virus diseases do, certain maladies caused by bacteria. Its symptoms take the form of numerous dark brown spots or lesions on the leaves, and may or may not develop into the form known as "Leaf-Drop-Streak," where the leaves shrivel up and drop down one after the other, finally bringing about the death of the plant. Streak is the most perplexing of all the potato virus diseases; it is often found associated with either Mosaic or Crinkle, and its precise connexion with these two virus diseases has not yet been determined.

The last virus disease of the potato to be considered is of an entirely different type and, when it occurs in quantity, is the most serious from the agriculturist's point of view. This disease is known as "Leaf-Roll" and is so-called because the leaves of an affected plant become harsh and leathery, and the leaflets roll up in a characteristic manner. A badly "rolled" plant is a pitiful object; it is small and stunted, and its leathery leaves rattle in the wind, while the yield of tubers from such plants is, as may be imagined, entirely negligible. All the viruses pass down into the tubers, and are thus carried on from year to year.

### Some Common Potato Insects and the Part played by them in the Dissemination of Potato Viruses.

Mention has been made of the infectious nature of potato virus diseases and their spread to neighbouring healthy plants in the field How, then, can this be brought

about? To consider artificial methods of transmission first, diseases of the Mosaic group can be transmitted from a diseased potato plant to a healthy one either by inoculation of the juice by needle scratch or by grafting a scion of a diseased plant on to a healthy stock. The Leaf-Roll virus on the other hand cannot be needle-inoculated from a diseased plant to a healthy one, but can be transmitted by grafting. Obviously, however, since these are artificial methods of spread, it cannot be by them that infection is disseminated in nature. There must be a third method, and a very efficient one, to account for the universal distribution of potato viruses. What is the counterpart in nature of the inoculating needle of the laboratory? The answer to this question is that one or more of the insects which feed upon the potato plant, in so doing, transmit the infective principle or virus. There are many insects which normally live upon the potato plant, and it will be necessary briefly to consider these in their relation to the potato viruses.

Insects can broadly be divided into two groups, according to their methods of feeding, *viz.*, (1) those that eat the leaf substance and are known as "biting" insects, examples of which are caterpillars, beetles, etc., and (2) those that have no "jaws" in the accepted sense, but suck the plant sap by means of a hollow, needle-like proboscis, which is inserted into the plant tissue. These are known as "sucking" insects, and the best-known example of this class is the green-fly or aphis of the rose. Although biting insects may be found to transmit the virus diseases of other crops, it is with the latter class only that we are concerned in dealing with the viruses of the potato.

There are three main types of sucking insects which attack the potato plant:—(1) the green capsid bug, closely allied to the apple capsid, (2) the leaf-hopper, a small, active, black and yellow or pale green creature, and lastly (3) the aphis or green-fly. The first problem, then, to be solved is which, if any, of these insects is capable of transmitting the virus? Study of plant viruses and their insect-transmitting agents has revealed the interesting fact that there is usually one particular species of insect that appears to possess an affinity for a particular plant virus, and this virus can be carried by no other insect. Careful experiments with all the sucking insects of the potato have revealed a state of affairs of this kind. The writer's experiments have shown that one particular species of aphis possesses a marked affinity for several of the potato viruses, and will carry them from diseased to healthy plants with great efficiency; this applies specially to the virus of Leaf-Roll. The other insects, such as the capsid bugs, leaf-hoppers, and the remaining species of aphides, have failed to transmit the diseases. It may be well to mention here that the mere feeding of the capsid bugs on the potato plant does cause some injury to it which shows itself in the destruction of the young shoots and the production of a "shot-hole" effect on the older leaves. This condition, known as "stung" in some parts of the country, is due to certain toxins in the insect's saliva, but has no connexion with virus diseases.

The aphis referred to, known as *Myzus persicæ* Sulz., is a small green species, smaller than that usually found on roses. Like other aphides, it occurs in both winged and wingless forms, the winged form being green with black markings. It can be recognized by the shape of the "cornicles" or "siphons" on the back, which are swollen at the ends. Unfortunately *M. persicæ* is an exceedingly common insect; it is practically cosmopolitan, occurring over almost all the world, and it is able to feed upon very many plants of widely differing families This aphis is concerned also in the transmission of other plant viruses and is likely to develop into an insect of world-wide importance. It has been proved by the writer to transmit no less than five virus diseases of the potato. Both winged and wingless forms can carry infection, but the winged form, of course, is able to disseminate the virus over a wider field.

What is the mechanism by which the virus is brought from diseased to healthy plants? As already explained, the aphis feeds by thrusting its sucking beak into the plant tissue. This beak is provided with two channels, down one of which flows the insect's saliva which mixes with the plant sap, and up the other, drawn by the action of a pharyngeal pump, flows a mixture of sap and saliva. Thus, it will be understood that an aphis which has sucked up some sap from a virus-infected plant and then moves on and feeds upon a healthy one acts as a kind of animated hypodermic needle, and injects the virus along with its saliva.

This explanation is quite straightforward, so far as the Mosaic group of diseases is concerned, because it is known that these are transmissible by the needle. It is not quite so clear, however, with Leaf-Roll, a disease which cannot be transmitted by needle, but is very easily transmitted by *M. persicæ*. Here is a case where there may possibly be some essential connexion between the Leaf-Roll virus and its insect carrier. It may be that the virus undergoes some slight modification within the body of the aphis, and that this must happen before the virus can become infective to a new plant. In this connexion the following points, which have been disclosed by recent experiments, are of interest. It has been found that *M. persica* which has been feeding for some days upon a potato plant affected with Leaf-Roll, if allowed to feed for two hours upon a healthy potato plant, will transmit the virus in that time, the plant developing symptoms, under glass-house conditions, ten to fourteen days later. Conversely, *M. persicæ* from a cabbage or some such immune and thus non-infective plant will pick up the Leaf-Roll virus from a diseased potato plant in six hours. The whole process of infection of aphis and healthy plant, however, cannot be performed in eight hours. There seems to be a minimum period of about 54 hours before the non-infective aphis can become infective to a healthy plant. This may mean that there is some relationship between the virus and its insect carrier, or it may merely be the time necessary for the virus to travel round the body of the insect and return *viâ* the salivary juices. Further investigation of this point is necessary before any dogmatic statement can be made. The practical

point arising, however, is that *M. persicæ* can infect a healthy potato plant with Leaf-Roll after feeding for only a very short time.

It has been shown that healthy potato plants may become infected in the field with virus diseases brought to them by the aphis, *M. persicæ*, from neighbouring diseased plants. There exists, however, another opportunity for infection which should not be overlooked. Besides feeding on the growing plant in the field, *M. persicæ* is also a sprout-infesting aphis, and is often found feeding upon the shoots of " seed " tubers in the sprouting trays. By feeding infective aphides upon the shoots of known healthy tubers in February, the writer has produced a crop of badly " rolled " plants at the end of March. The plants in this case were grown in a glass-house, but the effect would have been the same, though delayed, if they had been planted in the field. Thus it is possible for the virus to become distributed to a considerable extent among the sprouted tubers, and for healthy " seed " tubers to become infected before they are planted in the ground.

## Plant " Carriers " of Virus Disease and Sources of Infection in Nature.

The investigator working upon virus diseases of the potato is seriously handicapped by the existence of certain varieties of potato which behave abnormally in their reactions to virus diseases and which may be termed " carriers." Put briefly, this means that these potato plants, although outwardly perfectly normal and healthy, yet carry in their sap one or more potato viruses. That is to say, the virus exists in a quiescent yet infective condition within the " carrier " plant, which itself exhibits no disease symptoms. If a scion from such a plant be grafted on a healthy plant of another and susceptible variety, the disease develops in the latter, although the scion continues to show no symptoms. Parallel cases of " carrying " may be quoted in certain diseases of man : typhoid, for example, though of microbic origin and not due to a virus, is sometimes carried by a person who, himself healthy, is capable of infecting other and susceptible persons. Here, then, is a very serious complication for the potato virus worker, who must first of all discover whether his potato plants are free from hidden viruses before any scientific studies can be made. Apart from this, however, the existence of these plant " carriers " is of practical importance. It is quite possible that such potato plants may act as reservoirs of infection in nature, from which the aphis can transmit disease to neighbouring healthy but susceptible varieties. In the present state of knowledge of this subject, however, it is not possible to state exactly to what extent the aphis can infect susceptible potato varieties from " carrier " plants. Should infection be carried in this manner—and experiments are under way to determine the point—it will be a matter of great importance. In the future it may be proved to be as bad agricultural practice to grow certain varieties of potato in close proximity as it is known at the present moment to be to grow wart-susceptible potatoes in wart-infected soil.

It should be realized that a "carrier" plant is quite a different thing from an "immune" one. The potato varieties which are really immune from wart disease, for example, do not take the disease at all, and the wart organism cannot live within them. In a virus carrier, however, the plant has the infective principle within itself, but, for some reason, is tolerant of it and shows no unusual symptoms. Such a plant though "carrying" one virus is quite likely to be susceptible to or intolerant of another. The virus most frequently "carried" is that which produces "Streak," and a well-known Streak-carrying variety is "Up-to-Date;" but this variety can be infected by, and show symptoms of, both Mosaic and Leaf-Roll.

So far, no potato variety is known which is immune from virus diseases, though there exists a wide range of difference in varietal susceptibility and in reaction to the different diseases. Recent work at Cambridge has revealed the existence of reservoirs of virus infection other than the potato itself. It has been found, for example, that the common Solanaceous weed, Black Nightshade (*Solanum nigrum*), is not only frequently infected with certain potato viruses, but is an almost perfect "carrier" of such viruses, exhibiting no symptoms other than a faint mottling of the leaves which disappears with the continued growth of the plant. Again, the Black Nightshade is a common host of the virus-carrying aphis *M. persicæ*, so that all conditions necessary for the transmission of infection are fulfilled. Experiment has proved that in this case, at least, the aphis can transmit infection from a "carrier" plant to healthy, susceptible varieties of potato. In the glass-house some individuals of *M. persicæ* were colonized upon a plant of Black Nightshade suspected of harbouring a virus; after a few days' feeding they were transferred to healthy potato plants, *var.* "President." In about ten days the "President" plants developed a very serious disease the symptoms of which took the form of a severe crinkling of the uppermost leaves, together with Streak in its leaf-drop form. The experiments were then repeated, but this time *M. persicæ* was collected, together with other species of aphis, from various Black Nightshade plants growing among a potato crop nearby. The aphides were then transferred, as before, to healthy potato plants. In nearly every case the potatoes colonized with *M. persicæ* developed the Crinkle and Leaf-Drop disease, while in every case the potatoes colonized with the other species of aphis from the same Black Nightshade plants remained healthy. In one instance a single, winged female of *M. persicæ*, transferred from a Black Nightshade plant in the field to a healthy potato plant, was sufficient to infect the latter with the Crinkle and Streak disease and render it entirely useless for tuber production.

The degree of importance which attaches to this discovery depends to a certain extent upon two points. Firstly, is Black Nightshade capable of acting as a biennial weed, and, secondly, is the virus carried by the seed? Either of these factors would ensure the retention of the virus until the following year. The Black Nightshade must first itself become infected by the aphis from a virus-infected potato

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before it can act as a reservoir of infection. Although the fact of such virus-carrying weeds growing in the midst of an already infected potato crop is important, yet it is obviously more important if a new and possibly virus-free crop of potatoes should be planted the following year among or even close to numbers of virus-carrying weeds. There is little doubt that Black Nightshade does act as a biennial weed; it also seems to produce fresh plants from pieces of root-stock left in the ground over winter, and such plants would, of course, contain the virus, for it is present in every part of the plant. The question of transmission through the seed is more doubtful, as plant viruses are not often transmitted in this manner.

It is thought that one of the chief reasons for the comparative freedom of much Scottish "seed" from virus disease is the scarcity of the aphis carrier in that country. Therefore, if stocks of virus-free tubers could be raised in England under insect-free conditions, there seems little reason why they should not be equally as good as Scottish "seed." Large stocks of virus-free potatoes are accordingly being raised under insect-proof conditions at the potato virus station at Cambridge by Dr. R. N. Salaman, and if these can be propagated further, on a commercial scale in English localities, under conditions where infection cannot occur or is at any rate reduced to a minimum, the problem of supplying English growers with satisfactory home-grown "seed" will be solved.

As regards prevention of infestation of the sprouting tubers in the seed trays by *M. persicæ*, it is well worth while to fumigate the store or shed containing the trays twice a week. This can easily be done by heating a small quantity of pure nicotine in a metal saucer on a tripod over a spirit lamp. As regards the elimination of diseased plants in the field, something may be done by "roguing" out affected plants as soon as symptoms appear. This method, however, is practicable only with a virus disease like Leaf-Roll, where the symptoms are obvious and easily recognizable, and where the complications of "carriers" with suppression of symptoms are less likely to occur.

It will be realized, even from such a brief article as this, that the potato virus problem is a complicated and important one, and that its solution is yet far to seek.

# PRESENT POSITION IN REGARD TO THE CONTROL OF PRICKLY PEAR (*OPUNTIA DILLENII* HAW.) IN CEYLON BY THE INTRODUCED COCHINEAL INSECT *DACTYLOPIUS TOMENTOSUS*, LAMK.

(*The following is the summary appended to the article under the above title by Mr. F.P. Jepson, M.A., Assistant Entomologist, Department of Agriculture, Ceylon, published in* The Tropical Agriculturist, *Vol. LXXV, No. 2, August 1930.*)

1. *Dactylopius tomentosus* was introduced into Ceylon, through the agency of the Australian Commonwealth Prickly-pear Board in August 1924 for the purpose of controlling *Opuntia dillenii*, a species of prickly-pear which had taken possession of a large tract of country in the north of the Island.

2. The two common pest pears in Ceylon are *Opuntia dillenii*, chiefly prevalent in the north, and *O. monocantha* more common in the south. The latter has been under control in Ceylon for many years by the wild cochineal insect *Dactylopius indicus*, believed to have been derived from Madras about the middle of last century. This species is not a parasite of *O. monocantha*. The essential differences between these two species of *Opuntia* are mentioned.

3. The introduced parasites were acclimatised at Peradeniya and propagation was continued until sufficient material was available for distribution.

4. The first cultures were liberated in March 1925 at Fort Frederick, Trincomalee, where a large area of pear scrub was cleared in eighteen months. Further distribution in this district was also successful. At the present time only occasional isolated plants are to be seen and the large ones are infested by the parasite.

5. The insect was established on the island of Delft in April 1926 after several unsuccessful attempts extending over one year. The spread was rapid and by April 1928 colonies were to be found all over the Island.

6. In June 1925 the insect became established at Jaffna and the local supply of the parasite was augmented, periodically, from Peradeniya and also from Trincomalee. Extensive distribution has been made in the Jaffna peninsula, all the principal centres having received supplies of infested material. The experiment has been most successful in this region and the pear has been completely eliminated from certain areas. Land which was previously occupied by *Opuntia* scrub, 6-10 feet high, is now under cultivation.

7. The Mannar supplies of the parasite were obtained from Trincomalee in October 1926 and successful establishment was effected at Mannar town and Pesalai. The results of the introduction to this quarter are particularly striking at Pesalai where a large area of land has been reclaimed from the pear. There is scope for considerable extension of the work of distribution in other districts of this island where the pear is of particularly vigorous growth.

8. Distribution to certain other centres has failed owing to the prevalent pear in these localities being *O. monocantha* and not *O. dillenii.* The importance of recognising the difference between these two species is emphasised.

9. Cultures from Peradeniya have been forwarded to, and established in, Mauritius and South India. An area of 40,000 square miles is said to have been already reclaimed from this weed in the Madras Presidency entirely by the agency of this insect, and an area nearly three times this size is expected to be cleared in ten years' time. A large extent of country has now been made available for cultivation for the first time for many years. Land valued at a lakh of rupees has been freed of pear in the Tuticorin district alone.

10. In conclusion, it is considered that this introduction has been amply justified by the results obtained. The necessity for aiding the parasite by disposing of isolated leaves which appear in the cleared areas is apparent in Mannar, Jaffna and Trincomalee and the attention of agricultural officers, in the districts concerned, to this important matter is required. Another important point which should be impressed upon the cultivators in the districts where the insect has been established is that they have nothing to fear from this introduction so far as their crops are concerned. The difference between this beneficial Coccid and the injurious types requires to be pointed out to them as unless their complete confidence in the utility of the campaign can be secured, and maintained, there is a danger of much valuable land again reverting to pear scrub in certain districts of the Island.

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# POKKAH BOENG DISEASE OF SUGARCANE.

(Reprinted from the *Report of the Porto Rico Agricultural Experiment Station, 1928.*)

The sugarcane disease known as "pokkah boeng"* which is common in Java and in Louisiana, Cuba, and Hawaii, especially on recently introduced Java seedlings, was observed at the station in January, 1927, on a hybrid produced by crossing P. O. J. 2725 and S. C. 12/4.

The symptoms of the disease in Porto Rico agree in certain respects with descriptions of those occurring in Java and Cuba. Chlorotic spots on the leaves, usually near the base, are said to be the earliest symptom. These spots are apparent on unrolling leaves and are not developed on expanded leaves. In some instances wrinkling of the chlorotic areas occurs; in others, there is no distortion, and in yet other instances conspicuous wrinkling occurs on otherwise apparently normal green tissue. In some instances a chlorotic wrinkled area may appear near the base of a leaf and on the succeeding leaf a wrinkling of similar pattern may appear about half way between the base and the tip, whereas in the second succeeding leaf the wrinkling may appear near the tip. The position of the wrinkled areas indicates that the wrinkling occurred while those areas were in close contact in the leaf spindle.

The chlorotic areas usually show red or reddish-brown spots or streaks soon after the leaf unrolls. In Java and Cuba a further stage of the disease is said to be a top rot. In Java the infection is reported to extend into the stalk below the growing point, where it causes cavities and strands of reddish tissues which are crossed by dark bands, producing a ladder like appearance. These latter symptoms have not been observed in Porto Rico.

The varieties on which the chlorotic spots most frequently appear are the Java canes produced by crosses between P. O. J. 2364 and E. K. 28, and on crosses between the progeny of this cross and other varieties. Among the progeny of the P. O. J. 2364 and E. K. 28 cross, the varieties P. O. J. 2725, P. O. J. 2714, P. O. J. 2878, and others are susceptible. Of these, the P. O. J. 2878 seems to be the most frequently affected. Crosses between P. O. J. 2725 and S. C. 12/4 are very frequently affected. The stool on which the disease was first noticed, carried in the station records as J. S. C. 363, showed the chlorotic spots more conspicuously than did either P. O. J. 2725 or P. O. J. 2878. A number of other seedlings produced by the station and by the Fajardo Sugar Co. produced leaves similarly affected. Other varieties occasionally produced leaves with slightly chlorotic spots, but no distortion has been observed.

The effect of the disease on the cane is problematical. At the station a planting of P. O. J. 2878 made in March, 1927, began to show chlorotic spots in June of the same year. The cane continued to make apparently normal growth to maturity.

* Javanese words signifying "damaged top."

Ratoons from these stools showed no abnormalities until they reached a height of 4 to 5 feet. They, too, then began to produce occasional leaves showing the typical chlorotic area near the base. These ratoons are now mature. No cases of top rot have occurred, and, so far as it can be determined, the cane has not been injured.

The first planting of P. O. J. 2878 for commercial purposes was made by the Coloso Sugar Co. near Aguadilla. The cane was being propagated continuously, and the planting contained stools of various heights ranging from a few inches to 9 or 10 feet. Each stool was examined carefully for evidences of infection. The planting contained 685 stools, of which 73 were found to have a chlorotic area at the base of one or more leaves. In 12 instances reddish-brown discolorations were observed in the chlorotic areas, usually being accompanied by splitting of the tissue.

In the planting 33 cases of top rot (dead growing point) were found. Of these, 25 occurred among very young canes and were caused by insect pests, usually the mole cricket and in a few instances the moth borer. The insects had fed upon the young leaves in the leaf spindle or the growing point. Of the eight cases found among older canes, five were caused by the moth borer and three were due to some undetermined cause. Of the latter, two occurred on stalks which showed no evidence of "pokkah boeng." The third occurred on a stalk having three leaves with chlorotic markings.

Very young stools less than two feet tall showed no disease. Symptoms were observed on six stools two to three feet high, five stools four to five feet high, three stools six to seven feet high, and 59 stools eight to ten feet high.

Among the stools two to three feet tall only traces of chlorotic areas could be seen. The distribution of the entire population into the different height classes was not made, but the class two to three feet tall appeared to be the largest.

The above observations were made following a season of abnormally wet weather which would appear to favour infections. Of interest in this connection was the appearance of a red stripe disease, probably bacterial in nature, on the emerging leaves on four stalks. The latter disease is probably identical with one previously observed on B. H. 10/12.

Small plantings of P. O. J. 2878 have been made in many sections. Visits were made by the Plant Pathologist to some of the oldest of these at Santa Rita, Fortuna, Central Mercedita, Aguirre, Caguas, Humacao and Fajardo. At each place cane eight feet or more in height was growing. In every instance some chlorotic leaf bases could be found. No cases of top rot were seen, and no evidence could be obtained that any had ever occurred. The plantings of this variety were being watched with much interest, and it is unlikely therefore that a dead top would have escaped notice.

Isolations from the reddish discoloured tissue from chlorotic spots yielded two Fusarium strains. Fusaria were present in about 90 per cent. of the approximately 200 platings examined. The two strains were obtained in almost equal numbers.

Since the chlorotic areas are reported to be the earliest symptom of invasion, it was considered probable that the causal organism might be obtained from young chlorotic spots with most certainty. Accordingly, more than 200 platings of young spots showing no reddish or brownish discolorations were made. The tissues plated were obtained from the varieties P. O. J. 2878, F. C. 933, F. C. 915, F. C. 937, B. 417, and M. P. R. 14. The plantings from which the leaves were obtained were located at Maya-guez, Santa Rita, Fajardo, Central Mercedita, Humacao, Caguas and Fortuna. In no instance was a Fusarium obtained.

At the same time nearly 50 pieces of tissue of P. O. J. 2878 showing discoloration were plated, and Fusaria were obtained from 93 per cent.

Inoculation experiments have shown that the Fusaria are very weak parasites capable of causing only insignificant lesions even when placed on the wounded central roll of young leaves and kept constantly wet. No traces of chlorotic spots resulted. Inoculations of cuttings by injections of suspensions of the fungi failed to produce the disease in the daughter plants, or to effect the germination of the cuttings. Efforts to transmit the disease by planting cuttings from diseased stalks were not successful. The investigations are being continued.

# STRIPPING OF SUGARCANE FOR LIGHT AND AIR.

BY

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(Reprinted from *Facts about Sugar*, Vol. XXV, No. 26, p. 702).

The abandonment of the process of trashing or stripping so much in vogue in an earlier day, which process aimed at the same admission of light and air now put forth by some advocates of wide spacing of sugarcane, ought in itself to be sufficient repudiation of such recommendations. In the first decade of the present century this expensive practice was practically universal in such progressive sugar-producing countries as Hawaii, Porto Rico and Queensland, and one of the most useful accomplishments of the experiment stations of those countries has been the demonstration not only of the uselessness of the methods of admitting light and air to a plant which stands in no need of such large quantities of those elements for the stalks and lower leaves but of the actual damages caused by this process and the financial losses which it has exacted. We should never forget that the stalks of sugarcane are nothing more than the warehouses of the plants wherein the products elaborated by the chemical laboratories of the leaves are stored up and that no amount of exposure of these warehouses to light and air is going to change the composition of the products stored therein. The amount—the surface exposure—of light and air over an acre of cane is exactly the same whether the cane is planted in rows three feet apart or in holes twelve feet apart and as the processes incident to the conversion in the leaves of the plant food of air and soil into the sugars which we desire to harvest are carried out largely in the newer and upper leaves there would seem to be no good reason for going to the expense of admitting more light and air to those parts of the growing plants which do not require them in such abundance, to say nothing of the actual damage that was frequently caused when this process of stripping was employed by injuries to the cane through the plucking of leaves still performing their laboratory duties.

Eckhart in three exhaustive series of experiments at the Sugar Planters' Experiment Station in Hawaii, the result of which are set forth in Bulletins 16 and 25 of that station, thoroughly demonstrated the uselessness and financial loss from stripping in Hawaii, finding that the percentage of sucrose was higher in the juice of the unstripped canes, that the unstripped canes gave considerably higher tonnage yield in the field than the stripped canes, and that at harvest time there were always considerably more dead canes in the stripped than in the unstripped canes. In other

words, stripping was not only not advantageous to the cane but on the contrary was definitely detrimental. Since the publication of Eckhart's experiments, stripping in Hawaii has been practically abandoned.

Crawley [1915], who had had experience in Hawaii before establishing the Insular Experiment Station in Porto Rico, carried out a number of stripping experiments at the Porto Rican Station from 1912 to 1914, and concluded that the results "would seem sufficient to show that stripping cane under conditions that obtained here is a waste of time and money." Guanica Centrale, about the same time, conducted several experiments in the San German Valley, where at that time it was the general custom to strip all cane, to determine the results of stripping from a sucrose and purity standpoint. In each of these experiments it was found that the juice from the unstripped cane was higher in sucrose and purity than from the cane that had been stripped. In a letter received from the management, it was stated—

"We do not believe that any benefit is derived from the stripping of cane, and are convinced that a good deal of injury may be caused to the cane by the injudicious tearing off of the green and partly dried leaves............. We some years ago issued a standing order that this work was to be discontinued on all our properties, and I am sure that we have lost nothing by so doing. On the contrary, we have saved an annual expenditure of an average of about $2·00 per acre, the price usually paid for this class of work, over a total of about 15,000 acres in cultivation by this company, or a total of $30,000 per annum."

This letter is but indicative of the general abandonment in Porto Rico of the process of "admitting light and air" through stripping.

Another interesting case in this regard is that of Queensland, whose sugar planters main protest against the much discussed "white Australia" legislation was based on the ground that white men were incapable of carrying on the onerous and necessary work of stripping the cane. It was found, however, that the abandonment of this process not only failed to lower the yields of cane and sugar per acre, but saved the sugar men a considerable sum which they had until then been spending in an entirely useless and largely ornamental system.

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# SOILS AND FERTILIZERS IN SOUTH AFRICA*.

BY

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The problems of South African agriculture which await solution fall into two groups—those of arable and those of grassland. Of the two, the problems of grassland are potentially of greater importance.

## Grassland.

The grasslands of South Africa are poor and barren. Over vast areas the scant herbage serves scarcely to cover the ground even during the growing season. It turns brown and grows yet scarcer during the dry season. There are green hills in Natal and green pastures, and even in regions of low rainfall after summer showers the brown herbage grows green again. There are large areas of grassland in which the spring herbage is luxuriant and nutritious, but as spring advances the feeding value of the grass declines and cattle have often to submit and succumb to conditions of starvation.

It seems to be universally assumed that this state of affairs is due to lack of water and that it can best be remedied by introducing from other countries grasses of greater powers of resistance to drought. Much work of great interest along these lines, both on irrigated and non-irrigated land, has been done in South Africa, particularly by Dr. Pole-Evans at Pretoria. He has shown that it is possible to establish many grasses from other parts of the world and to obtain large amounts of food for stock from them. But the suggestion which has now to be made casts doubt upon this method as being the most important means of rejuvenating the pastures of South Africa. This suggestion is that many of the troubles attributed to drought are more properly to be ascribed to mineral deficiency. The hunger of the soil for phosphates is only one symptom, albeit a most important symptom, of these deficiencies. The land, or much of it, also lacks lime, and although the lack is well known, little is being done to remedy it. Yet lack of lime may prove to be a limiting factor of yield on both arable and grassland. Many officials maintain that the addition of lime depresses yield, and fail to consider that this in itself may be a passing symptom of a deep-seated trouble and want. It is encouraging therefore to report that both in Natal (Cedara) and in Rhodesia (Salisbury) experiments are now being carried out which point to benefits from liming.

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With an insufficiency of lime and phosphates in the soils the herbage must perforce be deficient in these essential materials ; the yellow or pale green colour of the grass betokens that it lacks nitrogen ; and it is certain that there are also deficiencies in potash. What other deficiencies there are of other more obscure elements which may prove to be important only further research will show.

It is suggested that all these deficiencies have been brought about by simple cosmic processes.

South Africa is the stem of a funnel, the mouth of which is the equator. Of all that teeming life bred in the warmth and moisture of the tropics there must from time to time, as bees swarm, have migrated hordes of all kinds of animals. Debarred by the desert from invading the north, these migrant hordes have gone ever southward. Sometimes the grasslands which these migrants invaded were lush with spring grass and sufficed to feed the beasts ; but at other times when the sun was fierce in summer and the growth of grass stood still, there was lack of herbage. Thus pushed by hunger, the herbivora grazed the pasture bare to the bone. The grass overgrazed became worn and thin. Like a garment too much used, the herbage became rent, and through the rents rains, often of torrential violence, pierced and swept away the soil, aggravating the effects of over-grazing. So the vicious circle was completed and remains complete to the constant impoverishment of South African soils.

Any traveller in the Union may see the rivers leap to life in the rains which attack the earth, carve it out and bear it away, and run red with the soil washed from the land. He may likewise see in the veldt-burning practised by farmers yet another aid to soil impoverishment : for though burning brings young and sweet and early grass, the partial sterilization of the soil which it produces releases the little store of hardly won organic nitrogen which is absorbed greedily by the young grass in the flush of its spring growth. The soil is soon depleted, so that long before drought imposes its veto, growth wanes and the veldt becomes brown and bare and barren. Flocks and herds are decimated, and the patient farmer praying for rain fails to realize that he himself offered them as a burnt-offering to the god of ignorance.

Under these conditions of over-grazing and erosion an age-long struggle for existence must have waged among the plants of South African grassland, and the struggle must have been of ever-increasing intensity as the soil became more and more depleted of its mineral contents and its nitrogen compounds. In this struggle those grassland plants with larger requirements of minerals and of nitrogen were the first to succumb. They ceased to be members of the grassland community but retiring from the unequal struggle, continue to survive here and there in those favoured mineral oases wherein their larger mode of life finds satisfaction. The struggle is still going on, and now only the most niggardly of the plants, mean in what they get and what they give, survive. Except for a brief period in the flush of spring they yield but little sustenance to the animals which graze upon them.

If this picture of the evolution of the grassland of South Africa be true, conclusions of fundamental importance follow. The first of these conclusions is that the restoration of South African pastures is possible. The second conclusion is that the way of improvement lies in the restoration to the soil of conditions under which plants of larger requirements and higher nutritive value may live. The third conclusion is that the picture of the decadence of grassland in South Africa, although more vivid, is none the less identical with the, albeit more drab, picture presented by the world as a whole. The factor which has determined the trend of evolution in this as well as in earlier geological epochs is the decreasing supply of minerals stored in the grasslands and arable fields of the world.

Deficiency of nutritiveness of the plants of arable crops means deficiency of nutrition in man and beast, which in turn means disease, and it may be that the wealth of animal diseases which Africa possesses is but another symptom of the gradually lowered vitality of living things due to gradual decrease in the supply of essential minerals.

If this be true, then in grassland management with its insistence on the restoration of minerals there are means of arresting the downward trend of evolution, or at least of slowing down the rate at which nitrogen and phosphorus escape, the one into space, the other into the abysms of the ocean.

Whether these large conjectures prove true or no, the first two conclusions require brief consideration. If it be true that a restoration of minerals to the soil brings about a return of plants of good grazing value, we shall have a most important vindication of intensive grassland management. For the general principle underlying the intensive management of grassland is that conditions may be provided wherein more nutritive native and introduced plants will flourish. That it will prove possible to transform the grassland of South Africa is rendered probable by the remarkable results which Mr. T. D. Hall's small-scale experiments on grassland in different parts of South Africa have already achieved.

These experiments show :—

(1) That grassland in South Africa responds in an almost magical way to nitrogen.

(2) That the relation between nitrogen and phosphates which obtains in grassland is the reciprocal of that which obtains on arable land. Though a dressing of phosphates adds but little growth to that produced by a single dressing of nitrogen, a dressing of phosphates added to double dressing of nitrogen brings about a marked increase. The explanation would appear to be that the grassland plants surviving to-day are able to extract even from the impoverished soil just enough phosphates to live on ; but in that grassland there is not enough nitrogen to go round, and so growth languishes until additional nitrogen is supplied. Addi-

tion of more nitrogen produces little effect. Addition of more phosphates as well as more nitrogen gives rise to a further increase in growth.

(3) The treatment of grass with a complete fertilizer together with lime gives the largest response.

These experiments suggest the conclusion that a brilliant future awaits South African grassland. It is even safer to conclude from them that our knowledge of the proper fertilizer treatment ot grassland is only just emerging from the empirical into the scientific stage, and that the investigation of the nitrogen-phosphate balance with potash in attendance will lead to the discovery that grass can be made far more productive than is at present supposed.

The opinion that grass will play an important part in the future of South African agriculture is reinforced when South African rainfall is considered. Much of South Africa is a land of summer rainfall. Grass is the opportunist among plants; it grows during growing weather and dies down when conditions are unfavourable to growth. A drought may cut off an arable crop in its prime, but it can rarely do more than check the growth of grass. Experiments now being conducted in Natal, at the Cedara School of Agriculture, lend confirmation to the view that grassland in South Africa will respond to intensive management no less readily than the grassland in Great Britain. Mr. R. A. Fisher's experiments show that even a grass (*Paspalum* sp.) reputed by farmers to be of low grazing value, responds to fertilizers so remarkably as to produce enough food during the grazing season to enable one cow to yield 1,000 gallons of milk.

One more suggestion may be made with respect to nitrogen on grassland. Owing to the intensity of the struggle for existence, grassland plants must always be hungry for nitrogen. Such nitrogen as grassland contains, and for which the plants have perforce to scramble, is derived from the breaking down of organic nitrogen compounds. The breaking down proceeds by orderly stages until compounds of ammonium are formed. The nitrifying bacteria then convert the ammonia first into nitrites and then into nitrates. It is usually believed that all plants of grassland, hungry as they are for nitrogen, wait passively until nitrate is formed before they attempt to supply their wants. It would seem more likely, however, that with capacities sharpened by the struggle, there would emerge from among some of the grasses the capacity to absorb nitrogen in the form of ammonia, or even in organic form, and such plants would be victorious in the struggle for existence. It may therefore be predicted that amongst grassland plants, some at all events may be found which possess the power of obtaining nitrogen in the form of ammonia, and it may prove that the grass family is distinguished from other plants by this capacity.

The dicotyledons, including the common weeds of pastures, can obtain nitrogen only in the form of nitrates, and to them ammonium compounds are poison. But the grass plants are able to utilize and thrive on the nitrogen obtained in the form of

ammonia. Two facts support these suggestions. The first is that sulphate of ammonia and ammonium phosphates have a lethal effect upon the common weeds ot grassland ; the second, that sulphate of ammonia is at least the equal of nitrate nitrogen in calling forth the growth of grassland in spring. This equality is difficult to explain if the common view be accepted that before ammonia can be utilized by the plants it must first be converted into nitrates.

The power of sulphate of ammonia to evoke early growth of grass would be self-evident were it to be proved that ammonium compounds are the proper nitrogenous food for grass, and, needless to say, such proof should be of great value. Of no less value should be the proof, it it can be obtained, that ammonium phosphate is the right fertilizer to use on a plant which responds markedly to a proper balance of nitrogenous and phosphatic fertilizers.

## Arable Land.

The arable crops of South Africa are poor. The yield of maize in the Union is on the average three bags to the acre, that is, about one-third of a crop even when measured by American standards. Poor cultivation is in part responsible for low yields, far more so indeed than seems to be realized in South Africa. Other limiting factors are water and phosphatic deficiency, and it is a general obsession in South Africa that most of the agricultural troubles from which that country suffers are due to lack of water. Science should aid effectively in curing this obsession. It has already shown that, in spite of low rainfall, crops can be produced if the deficiency of the soil in phosphates be made good. But even after applications of phosphates the crop remains small, and the expert attributes the low yield to insufficiency of water. In this he is partly, albeit only partly, right. When he adds nitrogen on the top of his phosphates the result is often disappointing, and he draws the conclusion that nitrogen, by encouraging the growth of leaf and stem and thereby increasing the loss of water from the plant by transpiration, does more harm than good by making the limited amount of water in the soil still more insufficient. For this reason the expert and the farmer avoid using nitrogen. Sometimes an additional reason is advanced ; namely, that nitrification goes on so quickly in South African soils that there will always be enough nitrogen available when the plant needs it.

The latter explanation may be considered briefly and dismissed. South African soils are desperately poor in organic matter. Organic matter is the sole source of supply of natural nitrogen. If the source of supply of natural nitrogen is almost non-existent, to believe that nitrification can supply enough nitrogen to the plant, is to believe in the making of bricks without straw ; albeit that it is possible to hold as has been suggested, that the plant residues in the soil supply just enough material to permit of an amount of nitrogen fixation sufficient, and no more than sufficient, to make good the annual loss through nitrification.

The extreme poverty of South African soils in humus and the essential part which organic matter plays in the feeding of crops are facts which those interested in the

use of fertilizers must take into careful consideration. Observations in South Africa have led me to propound some ideas which may throw light upon the role which organic matter plays in the soil. Hitherto it has been believed that the chief virtue of organic matter, apart from its physical effect on the soil, lies in the nitrogen which it supplies. Experiments made in South Africa on irrigated land are claimed by their authors to show that, whereas the addition of inorganic nitrogen produced no increase in crops, the addition of even so small an amount as one ton per acre of Kraal manure brings about marked crop increase. It is difficult, although perhaps not impossible, to believe that a small quantity of nitrogen in organic form is more beneficial to plants than a larger quantity of inorganic nitrogen. It is more reasonable to seek the benefit of the Kraal manure in the carbon which it contains, and it may be conjectured that the chief chemical role of organic matter is to supply carbon for the soil bacteria, and particularly for those soil bacteria which are engaged in nitrogen fixation. This consideration suggests a line of research of practical importance. If carbon in organic form be proved to play such an important part in enhancing soil fertility, it may become necessary to use as a filler in the manufacture of complete fertilizers some cheap waste product rich in organic carbon. There are expert growers, some of them among the best in the world, who act empirically as though they held this view and use always large amounts of organic matter together with artificials in order to produce large crops of fruit and vegetables.

Considerations of the bacterial changes in the soil lead to yet a further suggestion; the wattle growers in Natal have proved that phosphates give a much larger growth of the tree than is obtained without their use. Now in a fairly wide excursion throughout South Africa, one of the few signs of nitrogen plenty was shown in the green-black colour of the leaves of wattles treated with phosphates. The dark colour suggests that the wattles have received plenty of nitrogen. But the soil is poor in nitrogen. Therefore the trees must have obtained it from the nitrogen-fixing nodule organism which infects the roots.

Inquiry showed that on the roots of the phosphate-treated trees the nodules are far larger than on the roots of trees without added phosphates. Phosphates are known to encourage nitrogen-fixing bacteria, but it is now suggested that these latter organisms are no less intimately connected with phosphates than they are with nitrogen; in other words, that they not only bring nitrogen from the air into organic combination, but also that they do the like for the phosphates of the soil. If so, these nitrogen-fixing soil bacteria are the foundation-stones of soil fertility and their prevalence is determined first by the supply of organic carbon in the soil, and secondly by the supply of phosphates.

In support of this suggestion it may be mentioned that the nodule-forming nitrogen-fixing organism of clover is said to possess the power (denied to other grassland plants) of obtaining its phosphates from insoluble sources—a belief which could be easily verified. If it be true, it should be possible to balance, as a juggler does balls, the clovers and grass constituents of a pasture by supplying phosphates now in soluble,

now in insoluble form. If this possibility were achieved it would have great practical value. All these things considered, it may prove that although South African soils are at present poor, their defects can be gradually remedied by the systematic use of fertilizers containing nitrogen and all the essential mineral elements as well as carbon compounds in a suitable form.

Another and extraordinary fact lends confidence to this prediction. Trees of many kinds and in the different States of the Union--Natal, Orange Free State, and Transvaal—grow with far greater vigour than they do in Europe. This fervour of growth is attributed in South Africa to water. It cannot be : for water could at best make the trees grow only as fast as they grow in Europe and not faster. Therefore among contributing causes to the vigour of growth not the least must be larger supplies of minerals. Unlike surface-rooting plants, trees can dive deep in the soil and from the deepest layers recover the phosphates which have vanished from the surface.

Lastly, there remains to consider the second of the two alternatives already mentioned in explanation of current failure of nitrogen to give increased crop production on land treated with phosphatic fertilizers ; this suggestion may be stated thus. The amount of phosphates given to crops is 200 lb. to the acre—an extremely light dressing. The soils of South Africa are desperately hungry for phosphates. There is no reason to suppose that 200 lb. per acre satisfies their needs, especially for such a phosphate-greedy crop as maize.

Lack of phosphates may still be limiting crop production, and if so the addition of nitrogen would certainly do more harm than good. A double dressing of phosphates is known to give further increase of crop yields, but there is no reason why even a double dressing should completely make good phosphatic deficiency. There is evidence that 800 lb. or 1,000 lb. to the morgen goes on increasing yields ; and it is therefore suggested that the fundamental experiment is one in which a phosphate-needing plant (for example, maize) is grown in a series of soils which receive from 200 lb. or more per acre together with a uniform light dressing of inorganic nitrogen, in order to ascertain whether when phosphate deficiency is completely remedied, nitrogen does not begin to come into beneficient operation.

With that experiment should be made an inquiry into the morphological effect of phosphates, that is to say, the effect of phosphates on modifying the relative growth of the root system and the shoot system. Phosphates are known to encourage root growth. It is suggested that with progressive increases in phosphates root growth may be more and more increased with the corresponding discouragement of stem growth. That would mean that the plant becomes both a more and more efficient collector and a greater and greater economiser of water. For with increased root more water is absorbed, and with reduced leaf and stem loss of water from the plant is reduced. If this proves indeed to be the case, then a changed technique might vindicate nitrogen as a crop producer in the dry soils of South

Africa. The change would consist in regulating the amount of nitrogen in relation to the phosphates and in applying it as a top-dressing after development has proceeded to a certain extent, and not as at present with the seed. Along with this series of experiments there should be another which would analyse more completely than has yet been done the well-established fact that fertilizers increase water economy in the growing plants. It has been shown in India and elsewhere that when fertilizers are supplied to plants economy in the production of dry matter is increased. But at the same time the total amount of dry matter may be so increased as to make more demands upon the soil water-supply than are made by the plant which receives no fertilizers. One of the most important problems before scientific agriculture must therefore be a working out of the most water-economising ration of artificials to be supplied to different kinds of plants.

There are also experiments to be made in discovering varieties of maize and corn which will respond to fertilizers more effectively than those now grown, and there are also other genetical experiments which need to be carried out designed to discover races with male inflorescences which will continue to produce pollen over a long priod, so that even if drought comes there may still be some pollen left after rain has restored growth to the plant.

There are other experiments of no less essential importance in relation to liming—a practice which is neglected in South Africa- and there are yet others: to seek in carbon fixation carried on in uncropped soils the origin of the amazing renewal of fertility which fallowed fields display.

This sketch of the scientific problems which await solution shows incidentally how closely the future of the industry of agriculture depends upon the advances of pure science, and suggests how important it is for that industry both to encourage the investigations and to take part in them.

I found South Africa in large part barren land; it the ideas with which it has inspired me are true, they may yet make it fertile. I myself believe that a great future lies before that country, for I think that on those high uplands, so near the skies and so richly irradiated by the sun, the plants and the animals derived greater sustenance from the irradiated foods than do the animals of lower altitude and lesser suns. I believe, moreover, that in that great mineral deficiency which has been described lies the original source of all those troubles which South Africa endures. It is, I believe, defective nutrition that has brought in its train the many maladies which afflict man and beast. If so, when the grass is restored to its full vigour, animals will renew their youth and defeat the attacks of now victorious parasitic pests. On those parts of South Africa from which those parasites are banished the trees grow stronger than they do elsewhere, the men and women are sturdier, and even the flowers are more exuberant and more substantial than they are when we grow them under our sadder skies.

# THE CALCIUM AND PHOSPHORUS REQUIREMENTS OF FARM ANIMALS AND THE EFFECTS OF DEFICIENCIES.*

BY

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During the last few years, the relationship of diet to disease has received an increasing amount of attention in both human and veterinary medicine. It is now definitely established that there are certain diseases which are produced, not by the presence of a positive toxic agent, but by the absence of some essential food constituent. There is also a good deal of evidence in favour of the view that, even in the case of some diseases due to the invasion of micro-organisms, the state of nutrition of the host, determined by its diet, is an important factor in determining the degree of susceptibility.

The relatively high rate of growth and production in modern farm animals increases the importance of this aspect of preventive medicine. The more rapid the rate of growth or of the production of material of relatively constant composition, such as milk or eggs, the greater is the chance that there may be an insufficiency of some essential constituent of the diet, with the resultant appearance of definite deficiency diseases, and a weakening of what has been loosely termed " the constitution " of the animal, rendering it more susceptible to certain infectious diseases.

The classical schemes of rationing were confined to calories or starch values, and protein ratios. But in addition to the groups of fats, carbohydrates, proteins, and allied substances, on which the calculations for these tables were based, there is a large number of substances which, while not yielding energy, are absolutely essential for health. It is in connection with these substances, some of which are required only in minute amounts, that the main research work in nutrition is at present being done.

Of these non-energy-yielding constituents, those required in largest amounts are calcium and phosphorus. They not only form the main elements in the skeletal structures, but are present as essential components of every living cell.

The minimum amounts of calcium and phosphorus which must be assimilated and retained for the formation of new tissue in the growing animal, or to be elaborated into a product such as milk, can easily be calculated from the composition of the animal or the product. About 2 per cent. of the body weight of a bullock and 1 per cent. of a pig consists of calcium (calculated as CaO). The percentage of phosphorus (as $P_2O_5$) is only slightly less. A calf, putting on 1½ lbs. weight per day, must therefore absorb from the intestine and retain, approximately ½ oz. of lime per day, and a pig about ¼ oz. A gallon of cow's milk contains roughly ¼ oz. of lime and

* Paper discussed at the Veterinary Congress, Ayr, 1929.

⅛ oz. of phosphoric acid. A cow giving four gallons of milk a day is therefore subjected to a drain of 1 oz. of the former, and 1⅛ oz. of the latter. The hen, laying an egg a day, is perhaps the largest producer in proportion to body weight. An egg production of 200 per annum requires 1¼ lb. of lime.

The ration, however, must obviously contain more than these minimum amounts. There is a loss through ordinary "wear and tear," and, what is more important, only a proportion of what is present in the ration is absorbed from the intestine. The absorption of calcium appears to present more difficulty than that of phosphorus. There may be an abundant supply of calcium in the food, while, through difficulty of assimilation, the tissues may be short of lime. The amount absorbed from the intestine, as calculated from the intake in the food and the output in the fæces, may vary from 0 to over 80 per cent. of the amount ingested. It is obvious that the factors affecting the assimilation of calcium are as important as the amount present in the ration.

The highest assimilation is obtained in the case of nutural foodstuffs, *e.g.*, in the breast-fed human infant or the suckling calf. In such a case, provided the mother is in good health, the balance of the constituents of the milk is perfect for the suckling and all essential substances are present and are assimilated in sufficient amounts. But on ordinary rations such as are fed to animals indoors in winter, the conditions for assimilation are usually much less favourable.

The factors affecting assimilation are as yet imperfectly understood, though recent work has shown that they can, to some extent, be controlled.

The two factors which have received most attention recently are perhaps vitamins as present in cod liver oil, and ultra-violet light. The following figures (1)* illustrate the effect of cod liver oil on the assimilation of calcium.

TABLE I.

*Showing effect of C.L.O. on Assimilation of Calcium.*

Young hog pig on ration of maize, middlings, oatmeal and blood meal.

| Days. | Calcium intake grams CaO. | Balance grams CaO. | Calcium retained as percentage of intake. |
|---|---|---|---|
| 1—7 | 3·48 | +0·64 | +18 |
| 8—13 | 3·48 | +0·17 | + 5 |
| 14—19 | 3·48 | —0·36 | —10 |
| 20—22 | 3·48 | —0·48 | —14 |
| Cod liver oil given. | | | |
| 23—28 | 2·32 | +0·17 | + 7 |
| 29—34 | 2·32 | +1·54 | +66 |
| 35—40 | 1·70 | +1·16 | +68 |

* Reference by figure is to literature cited at the end of the article.

It will be seen that the addition of cod liver oil has raised the calcium retention from a minus quantity to over 60 per cent. of the intake. This is an exceptionally marked effect, chosen to illustrate the fact that, in the case of calcium, factors affecting assimilation may be as important as the amount present in the ration.

Irradiation with artificially produced ultra-violet light produces a similar effect, both in growing (2) and in lactating (3) animals. Thus, for example, in the case of young pigs, exposures to light from a carbon-arc lamp for one hour daily raised the calcium retention from 0·46 gram to 2·10.

TABLE II.

*Showing effect of Ultra-violet Light on Assimilation of Calcium and Phosphorus.*

Young hog pig on ration of oatmeal, maize meal, middlings and $CaCO_3$.

| Days. | Calcium intake grams. | Calcium balance grams. | Phosphorus intake grams. | Phosphorus balance grams. |
|---|---|---|---|---|
| 1—10 . . . . . . . . . | 4·11 | 0·46 | 10·18 | 1·88 |
| Irradiation commenced. | | | | |
| 10—18 . . . . . . . . . | 4·11 | 0·55 | 10·18 | 1·39 |
| 18—24 . . . . . . . . . | 4·11 | 1·78 | 10·18 | 2·54 |
| 24—32 . . . . . . . . . | 4·11 | 2·10 | 10·18 | 2·65 |

In lactating goats exposure to ultra-violet light for four hours daily had a similar effect.

| | Goat 1. | Goat 2. | Goat 3. |
|---|---|---|---|
| Average daily balance in grm. Ca :— | | | |
| Before light . . . . . . . | —0·24 | —0·41 | —0·25 |
| During irradiation . . . . . . | +0·16 | —0·20 | —0·01 |

The effect of the light was to diminish loss of calcium or to convert a loss into a gain.

The nature of the diet, in certain other respects, also affects the assimilation of calcium. Thus, for instance, a higher proportion of calcium appears to be absorbed from fresh pasture than from most other foodstuffs. In the case of hay the method of curing seems to be of some importance, assimilation being more difficult from hay that has been left lying cut for a long time than from hay secured with a minimum of exposure to the elements. The ratios of other constituents of the ration to calcium are also of some importance. Excess of magnesium may limit absorption. There is an optimum ratio of fat to calcium. The ratio of acid to basic radicles also has an influence, assimilation being more rapid when there is an excess of acid radicles.

Finally, the ratio of calcium to phosphorus is of importance, a large excess of either affecting the assimilation of the other.

In practice some of these factors, such as the influence of cod liver oil and exposure to sunlight, can be controlled. The question of the ratios of different constituents is more difficult, and consequently a sufficient margin must be allowed to provide for factors adversely affecting assimilation. As far as experimental evidence goes, it seems that with ordinary rations, about three times the amount required for constructional purposes should be provided (4). That means, in the case of a young calf, that the ration should contain about 1¼ oz. of lime per day, and in the case of a young pig about ¾ oz. A milk cow giving four gallons per day should have 3 oz. For animals grazing on good pasture these amounts are available. Good pasture contains about one per cent. of calcium in the dry matter (as CaO), so that a cow consuming grass equivalent to 30 lbs. of hay would obtain just over 4 oz. of lime per day. On poor pasture, however, the percentage of lime may be as low as 0·5 or 0·6, and on such grazing she would receive only about two-thirds of the amount of calcium needed for a four-gallon milk yield. On indoor rations, the likelihood of deficiency would be even greater, as most concentrates are relatively poor in calcium. Thus, for example, it would take 2 cwts. of a mixture of oats, bran, and maize, to yield 3 oz. of lime. The danger of a calcium deficiency arises therefore either when grazing on poor pasture or during indoor feeding on concentrates.

Acute phosphorus deficiency occurs in grazing animals in several parts of the world. The percentage of phosphorus in the pasture in some cases may fall to little more than a tenth of that present in good pastures. In this country, however, a phosphorus deficiency is, on the whole, much less likely to occur than is a calcium deficiency. On poor pastures the percentage of phosphorus may fall as low relatively as the calcium, but when feeding concentrates, on which the most acute calcium deficiency is likely to occur, there is a super-abundant supply of phosphorus. Thus, the 2 cwts. of grain mixture referred to above, which yielded only 3 oz. of lime, would give about 50 oz. of phosphoric acid. Further, phosphorus is assimilated with greater ease than calcium. On the whole, therefore, while "aphosphorosis" may be a very serious condition in various grazing areas throughout the world, it is not likely to occur to any marked extent in the more intensive methods of animal husbandry practised in this country. When it does occur, if at all, in this country, it is likely to be on poor pastures, and then it would be associated with a deficiency of both calcium and other minerals.

A deficiency of calcium or phosphorus in the diet leads to decreased rate of growth in growing animals and decreased production in full-grown animals. Some very striking figures are to be found in the literature, showing the extent to which rate of growth and production is increased when the missing element is added to a ration which is markedly deficient. Theiler's figures for cattle (5) show that the feeding of bone meal to stock grazing on phosphorus-deficient pasture resulted in a rate of

growth nearly three times greater than that of control animals on the same phosphorus-deficient diet without bone meal. The phosphorus deficiency had obviously restricted the rate of growth to a third of the animal's capacity. A similar, though less striking, result was obtained in the case of milk yield, the addition of bone meal increasing the output by about 40 per cent. Comparable figures could be given for other deficiencies. For instance, in the case of pigs on a calcium-deficient diet, the gain in weight in 124 days was 69·3 lbs. as compared with 132·8 lbs. on the same ration with the addition of a calcium-rich salt mixture.

The effect of deficiencies on growth and production is, however, of less interest to us here than the effect on the health of the animal. The metabolism of calcium is closely linked with that of phosphorus, especially in the bones. As might be expected, therefore, there are certain gross symptoms which arise with a deficiency of either. The animal becomes unthrifty, as shown by a staring coat, a tendency to emaciation, lethargy, and a stilted gait, or other abnormalities of locomotion. *Post-mortem* examination shows fragility or softening of the bones, which may be classified as osteoporosis, osteomalacia or rickets, according to the histo-pathological picture. Accompanying these symptoms, there is frequently a depraved appetite. The abnormal substance eaten is usually rich in the element deficient in the food, if such material is available.

The animals most likely to be affected are those with the highest requirements for calcium and phosphorus, namely, heavy-milking cows, and young calves and pigs. Fattening bullocks, beyond the most rapid stage of growth, and full-grown male animals often remain without any obvious symptoms of disease when cows and young animals are showing gross signs of deficiency.

Until a few years ago our information on this subject was derived chiefly from the investigation of cases occurring in veterinary practice. In recent years, however, observations have been made on experimental animals purposely fed on a deficient diet alongside control animals on a complete ration. Elliot and others (6) fed young pigs on a ration of oatmeal, bran, blood meal and potatoes, with some swede turnip, " marmite " and cod liver oil to prevent vitamin deficiency. The ration was markedly deficient in calcium. The animals showed the general symptoms referred to above. By the end of the third month bony deformities were evident. *Post-mortem* examination of the bones showed a reduced calcium and phosphorus content, excess of osteoid tissue, and disorganisation of the zone of proliferation of cartilage. Control animals, on the same ration with the addition of a calcium-rich salt mixture, grew at the normal rate and remained in perfect health. The requirements of the growing pig for calcium are very large, and there is no doubt that much of the disease in young pigs classed as rickets, or sometimes as rheumatism, now, fortunately becoming less common, is due to deficiency of lime in the food.

Some interesting and significant results have been obtained with breeding animals. Davidson (7), working at Cambridge, with sows, found that deficiency

of calcium was the cause of the birth of weak litters, with high mortality after birth, becoming progressively worse with successive generations. Breeding was impossible in the fourth generation. It was noted that there was an absence of udder development at parturition, and an obvious lack of milk during the suckling period.

In somewhat similar experiments with cattle at Wisconsin, Hart (8, 9) and others found that on a ration of ground oats and oat straw, cows failed to breed, or gave birth to dead calves. The addition to the ration of a calcium salt or crude limestone resulted in the birth of healthy, normal calves. These workers calculated that for normal reproduction there should be 0·45 parts of calcium per 100 of the ration, *i.e.*, about ½ per cent., which approximates fairly closely to the estimate made above of the requirements of the cow.

The most important of recent contributions to our knowledge of phosphorus deficiency are those made by the Onderstepoort station in South Africa. Reference has already been made to the limitation of rate of growth and milk production. The clinical picture includes the difficulty of locomotion and the bony changes which we saw to be characteristic. These workers definitely established phosphorus deficiency as the cause of the condition by showing that the phosphorus in the food was below the requirements of the animals, and by preventing or curing the condition by the administration of phosphorus-rich substances or inorganic phosphates. It is interesting to note that the more recent observations of the South African workers on the effect of phosphorus deficiency on breeding (10) are on the same lines as those of the American workers on calcium deficiency. The calves from the cows on phosphorus-deficient pasture were lighter at birth and weaker than those of control animals receiving bone meal.

Such obvious pathological changes as softening or malformation of bones and failure to reproduce are, however, merely gross manifestations of a general constitutional disturbance. They are accompanied by disturbance of the functions of the ductless glands, or other organs, although gross pathological changes are not so evident as those occurring in the bones. Since the ductless glands play an important part in the regulation of the composition of the blood, evidence of such changes has been sought in the study of the changes which occur in the blood. It is known that in rickets, either the blood calcium, or the phosphorus, or both may be lowered, and that return to the normal level precedes healing. Du Toit and his co-workers (11) found a low blood phosphorus in cows grazed on phosphorus-deficient pasture, and they showed that the weight and vitality of the calves were correlated with the level of inorganic phosphorus in the mothers' blood.

Alterations in the level of calcium in the blood are less easily produced, but in certain feeding experiments with rabbits, Morton found that on a low calcium diet the calcium content of the blood in young rabbits was usually lower than that in animals on a complete ration, although the difference was seldom more than 10 per cent.

Pigs on a diet deficient in calcium develop symptoms closely resembling tetany in children, a condition in which the blood calcium has been shown to be definitely below normal. Another interesting condition which is associated with a low blood calcium is milk fever. This disease, which usually appears during the first forty-eight hours after calving, is characterised also by the presence of tetany. Dryerre and Greig (12) have shown that the blood calcium in milk fever may be as low as about a third of the normal and that the lower the level, the more severe is the attack. Similar observations have been made independently by Little and Wright(13). Inflation of the udder, which is well known as the most rapid and effective cure, causes a rise in blood calcium, recovery being complete with its return to normal level. Lambing sickness in ewes has been shown by Greig to be identical with milk fever in cows. In both conditions, injection of a calcium preparation leads to recovery.

In an investigation on a tribe of East African natives whose diet consists chiefly of cereals, and is consequently deficient in calcium, it has been found that the blood calcium is below normal. A similar observation has been made by McCulloch in Nigeria.

Our information on the composition of the blood in relation to diet is, unfortunately, rather meagre, but what is available suggests that deficiencies of calcium or phosphorus in the diet, or a sudden drain of these elements, such as occurs at the onset of lactation, may cause a deviation from the normal physiological level. The question arises to what extent this deviation from the normal, in the circulating fluid, accompanied, as it must be, by disturbances of function of the ductless glands and other organs, will affect the resistance of the animal to the invasion of pathogenic organisms. We have very little experimental evidence on this point. Morton, however, in some work not yet published, found in experiments with rabbits that certain deficiencies in the diet are correlated with a reduction in the level of calcium in the blood which, in turn, is correlated with a decreased resistance to artificially introduced tubercle bacilli. In the East African investigation referred to above, a survey of the diseases occurring in the tribe on cereal diet, and in a neighbouring tribe on a meat, blood and milk diet, which is rich in both calcium and phosphorus, showed that pneumonias and tuberculosis were much more prevalent in the cereal-fed native than in the latter.

Du Toit, of South Africa, in a private communication to the writer, has stated that one of the most remarkable results being obtained in his experiments in the feeding of bone meal and salt in the phosphorus-deficient area, is the marked decrease in the death rate in the bone meal-fed groups as compared with the controls.

In some experiments on sheep which we have been carrying on for the past three years in areas where the pastures are deficient and where there is a high mortality, we have noted a decreased mortality in the groups, receiving supplementary feeding, making good the deficiencies in the pastures. The results are, however, too few to allow definite conclusions to be drawn.

The evidence which can be brought forward in support of the hypothesis that deficiencies of calcium and phosphorus in the food lead to decreased resistance to certain diseases is much too meagre to enable us to draw any conclusions. It is sufficient, however, to stimulate further investigation. If it should be shown that diet plays a part in affecting the resistance to certain common infectious diseases, there is obviously there a field of investigation of enormous importance in both human and veterinary preventive medicine.

So far the most enlightening work on this subject has been done, not in schools of human medicine, but in connection with farm animals. Veterinary medicine, apart from the deplorable lack of funds for research, is in a much better position to explore this field than is human medicine, and the field of observation is much wider. It includes different species of animals where the requirements are very high and where consequently there is liable to be a deficiency. The dietary history is much more straightforward and more easily obtained than that of human patients. Further, the clinical material can be easily subjected to experiment and *post-mortem* examination.

The ideal combination for research would be team work between the veterinary clinicians and the physiologists. It is from such combined effort that our knowledge of this subject is likely to be increased in the next few years.

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# VETERINARY SCIENCE AND AGRICULTURE.*

BY

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The prominent position which veterinary research occupies in the scientific life of South Africa to-day and the valuable practical results which have been obtained in this field of work have encouraged me to choose as the subject of my address the role which veterinary science plays in the agricultural development of a country. For obvious reasons my remarks will be confined almost exclusively to the live-stock side of agriculture in the wider sense ; and for equally obvious reasons most of my examples will be quoted from South Africa.

Since the beginning of the present century the growth of veterinary science has been remarkable. Indeed, it may be said that a new veterinary science has arisen unobserved by the general public. A quarter of a century ago the veterinarian was looked upon as a moderately useful, though obscure, member of the community, whereas to-day he is regarded as an essential factor in the economic machine of the State. In this transformation of veterinary science the British Dominions and Colonies played no unimportant part. The veterinarians who had migrated to those countries and taken with them the stock of knowledge which they had obtained at the European veterinary schools, found themselves confronted with new problems which required solution. Research work on a large scale became necessary. Novel methods of attacking disease had to be devised. The farmer soon came to realize that his very existence depended on the protective measures of the veterinary staffs.

I propose to review briefly some of the most notable achievements of veterinary science in recent years, and to indicate how the work of the veterinarian has become interrelated with that of workers in other branches of science.

## Animal Diseases.

*Trypanosomiases.* Probably no other single group of disease-producing organisms has retarded the agricultural development of the continent of Africa more than that of the trypanosomes. If the cattle population of Africa be estimated at about 40 million head, it is quite safe to say that this number could easily be doubled if the danger of trypanosome infection were removed. In Nigeria, for example, only a portion of the drier northern provinces is suitable for cattle ranching ; the much more fertile southern provinces are practically devoid of cattle on account of the ravages of trypanosomiasis. Similar conditions obtain in almost every territory in Africa

* From the presidential address to Section M (Agriculture) of the British Association, delivered at Bristol on Sept. 8, 1930.

(except the extreme south). The soil is fertile, grazing is plentiful, the climatic conditions are favourable, but the presence of tsetse flies and trypanosomes renders cattle farming impossible.

Fortunately, we can record considerable progress in this field of work during recent years. The problem has been attacked along two lines mainly. A direct attack has been launched against the parasite by means of drug treatment; and an indirect attack on the disease has been made through a campaign against the transmitter, the tsetse fly. The third line of attack, the immunisation of animals against infection, has not yielded very promising results.

One further trypanosome disease should be mentioned here, namely, dourine. Known for about a hundred and fifty years, this disease has been responsible for very heavy economic losses to horse-breeders in Europe and other countries. With the aid of modern methods the disease was eradicated from most of the closely settled and well-organised western European States. But in the vast open spaces of Canada and other countries its eradication proved to be a much more difficult problem. It was only when Watson in Canada succeeded in perfecting a delicate diagnostic test for the detection of the infection that the eradication of the disease could be attempted seriously, and the results of the subsequent campaign in Canada have been entirely satisfactory. It should be added that Watson's success has stimulated further research into the problem of diagnosing other trypanosome infections by serological methods. A fair amount of success has attended these efforts, and quite recently Robinson at Onderstepoort has reported further progress in the serological diagnosis of *Trypanosoma congolense* infection.

*Piroplasmoses.* Under this heading are included diseases like redwater or Texas fever of cattle, biliary fever of dogs and horses, 'gallsickness' or anaplasmosis, and East Coast fever of cattle.

Their etiology was completely obscure until Theobald Smith and Kilborne in America, in a series of brilliant researches extending over the years 1888-92, succeeded in elucidating the nature of the first-named disease. Not only did these investigators discover the causal organism in the blood of infected cattle, but they also proved that the disease was transmitted by ticks and that the infection passed through the egg of the tick from one generation to the next. All this was completely new to science; it was the first time that the transmission of a mammalian disease through an invertebrate host had been proved experimentally. This contribution to science by two veterinarians is worthy of special note.

In the case of redwater, great advances can be recorded. The direct method of attack is eminently satisfactory, thanks to the discovery by Nuttall and Hadwen in 1909 that the drug trypanblue has a specific action on the parasite of redwater of cattle and biliary fever of dogs. The treatment is so successful that the disease has lost much of its terror since the discovery of the value of this drug.

In the case of anaplasmosis, a method of immunisation has been practised in South Africa for nearly twenty years and has been the means of saving thousands of animals.

Of the diseases mentioned in this section, East Coast fever is the most formidable, because of the very high mortality attending it. This disease must have cost South Africa several million pounds since its first appearance nearly thirty years ago. The loss to the country has been partly direct through the death of many thousands of animals, partly indirect through the costly organization which it is necessary to maintain to fight the disease.

It is impossible in this brief review to discuss the methods employed in the eradication of East Coast fever, or the many practical difficulties encountered in this campaign. For our purpose it is sufficient to state that the dipping of cattle in an arsenical bath has proved to be a very valuable aid in the fight against East Coast fever or any other tick-borne disease.

In South Africa dipping has been practised since the beginning of this century, and has now become an integral portion of the daily routine of farming. No up-to-date stock farm can be found to-day without at least one dipping tank. Even if all the tick-borne diseases should now disappear, the majority of farmers in South Africa would continue to dip their animals regularly. The extent to which dipping is practised to-day may be gauged by the fact that there were in the Union of South Africa in 1929 more than 13,500 dipping tanks.

In the United States of America, where Texas fever (redwater) is the only serious tick-borne disease, an attempt is being made to eradicate completely the transmitter, *Boophilus annulatus*, by means of dipping. Large areas have already been cleared of these ticks, and the economic advantages to which these areas are entitled after being declared tick-free, more than compensate for the expenses incurred.

*Virus Diseases.* The vast sums of money which have been spent in Great Britain during the last few years on the eradication of foot-and-mouth disease should convince even the layman of the importance of this group of diseases.

In the olden days it was rinderpest which caused the severest losses. It has been calculated that the losses in Europe during the eighteenth century amounted to 200 million head of cattle. The disease made its appearance in England in 1865. A Royal Commission was appointed and its report is of value to this day. Later on, improved methods of eradication and prevention were evolved, and to-day most countries are free of rinderpest. However, in the Far East and in Central Africa the disease is till prevalent, and causes serious losses.

Two recent outbreaks of rinderpest, one in Belgium in 1920 and the other in Australia in 1923, both of which were eradicated completely within a few months, have again shown how far veterinary science has advanced during the last century

South Africa has been free of the two diseases just named for many years. But there are several other virus diseases which play a very important role. Among

these, horsesickness and bluetongue of sheep are perhaps the most important. An extensive study of the former disease by Theiler and his co-workers has yielded some very valuable results, but the problem of horsesickness cannot be said to be solved. At present a method of immunisation with hyperimmune serum and virus is practised, and this method has given excellent results in mules. About 4,000 mules are immunised annually, and it has been stated that if the Onderstepoort Laboratory had produced nothing else except this method of immunising mules, its existence would have been justified.

The second important virus disease of South Africa is bluetongue of sheep. The disease is of great economic importance and would have been a very serious hindrance to the sheep farmer had it not been for the fact that Theiler discovered a simple method of vaccination by means of which the losses from the disease can be reduced to a negligible quantity. Every year two to three million doses of this vaccine are issued to the farmers, and the ultimate saving to the country must be enormous.

Of the many other virus diseases of animals, only one more need be referred to here, namely, rabies. This most dreaded of all human and animal diseases has been eradicated from many countries, and is being kept out by strict quarantine measures. In 1918 the disease was introduced into England with a dog which had been smuggled in in an aeroplane. Strict measures were put into force and in a comparatively short space of time the disease was stamped out completely. Methods of preventive inoculation of dogs, in countries where the eradication of the disease is very difficult, have been tried on a large scale. The results have, on the whole, been very good; but it is too early to predict the future scope of these methods.

*Bacterial Diseases.* Of the host of bacterial diseases, only a few need be mentioned here. The deadly glanders, which was known before the time of Christ, and even twenty-five years ago still caused severe losses amongst horses and constantly threatened the human population, has now been practically eradicated from all civilized countries—thanks to the accuracy of the diagnostic tests which are used to identify the disease.

Another disease which at one time was responsible for very serious losses and which has now practically disappeared is pleuro-pneumonia (lungsickness) of cattle. In the year of 1860 about 187,000 head of cattle are stated to have died in Great Britain of this disease; and the mortality in other European countries at that time was correspondingly high. Towards the end of last century the disease was stamped out in Britain and to-day the greater part of Europe is free of the disease. South Africa, in spite of the fact that neighbouring countries are still infected, has been free of lungsickness since 1915.

Only one other bacterial disease can be mentioned here, namely, tuberculosis. In 1901, Robert Koch, who about twenty years previously had discovered the cause of the disease, startled the scientific world by announcing to a Tuberculosis Congress in London that human tuberculosis and bovine tuberculosis were two dis-

tinct diseases which were not communicable from the one species to the other. Unfortunately, this statement proved to be wrong. We know to-day that human beings do contract bovine tuberculosis, and for this reason most civilized countries adopt measures for the suppression of the disease in cattle. The United States and Canada are leading the world in this respect and have spent millions of pounds in compensation for the destruction of tuberculous reactors. Denmark, Germany, England, and other countries are also doing much and have achieved a large measure of success in their efforts to supply to the population milk and beef free of tubercle bacilli. But very much remains to be done. In human beings the mortality from tuberculosis is still high in all countries, and a considerable percentage of the deaths must be ascribed to the bovine strain of the organism. The disease in cattle *can* be stamped out provided enough money is made available.

Recently great interest has been shown in the attenuated strain of tubercle bacilli produced by Calmette and Guerin of the Pasteur Institute. Experiments in which it is attempted to immunise children and young animals, with this strain, are in progress throughout the world. It is sincerely hoped that all this work will prove that the method of Calmette and Guerin has given us yet another weapon against this insidious disease.

*Internal Metazoan Parasites*. The only group that need be mentioned in this brief survey are the worms. These parasites have become more and more important and to-day they actually constitute the 'limiting factor' in successful sheep farming in many parts of the world. This subject forms a highly specialised sicence of its own, the science of helminthology - in which many notable successes have been achieved in recent years.

The ordinary stomachworm of sheep (*Hæmonchus contortus*) is world-wide in its distribution and is the cause of very severe losses. Better farming methods will undoubtedly improve the position, but in the meantime farmers look to the veterinarian to rid their sheep of these deadly parasites. Various chemicals have been tried with varying degrees of success, but perhaps nowhere has the success been so marked as in South Africa, where, as a result of the researches of Theiler, Veglia, Green, and others, a method of treatment was recommended which has proved the salvation of many sheep farmers. The method consists of the accurate dosage of a mixture of arsenite of soda and copper sulphate; and the extent to which this method has been applied may be gauged from the fact that at present some 25 million doses of the mixture are issued annually from Onderstepoort. The method is not perfect, but it has been a great factor in making sheep farming a success where otherwise it would have been a dismal failure.

One further fact must be emphasized here. The menace of worm infection has become so great that no sheep farmer can hope to be successful if he disregards the teaching of modern science. Overstocking of farms must be prevented at all costs; marshes must be drained or the sheep kept away from them; sheep must be treated

regularly according to the best methods known. If these precautions are adopted, the parasites can be kept in check and profitable sheep farming will become possible; if the advice is ignored, then the financial loss to the farmer will be the smaller the sooner he gives up farming.

*External Parasites.* The two most important groups of ecto-parasites, the ticks and the tsetse flies, have already been referred to.

A further very important group are the mites. These minute parasites are responsible for the diseases known as scab or mange in animals, and have caused untold losses. In the fight against these diseases the British Dominions have had very signal success. Australia and New Zealand have eradicated sheep scab completely, Canada is practically free of it, and in South Africa, where the presence of a large native population owning a very inferior class of sheep has made the campaign particularly difficult, the incidence of the disease has been reduced to infinitesimal proportions and complete eradication is hoped for within a short time.

Another very important ecto-parasite of sheep is the so-called blowfly. The trouble is caused by these flies depositing their eggs in the wool of sheep, especially in the soiled and moist parts, and by the resulting maggots causing serious damage to the wool and the sheep itself. The pest has assumed alarming proportions in Australia and is becoming more and more important in other countries, including South Africa.

Determined efforts are being made to combat the pest and valuable progress has been achieved. In this research entomologists and veterinarians are working hand in hand.

*Diseases due to Poisonous Plants.* That certain plants are poisonous and may have fatal effects when consumed by animals has probably been known for centuries. However, it is only during recent years that plants have been studied which produce diseases comparable with epizootic diseases. In this field of research South African workers have been prominent.

One of the most remarkable of these diseases is that known in South Africa as gousiekte (rapid disease) of sheep, which was studied some years ago by Theiler, Du Toit, and Mitchell. The cause of the disease was shown to be the plant *Vangueria pygmæa.* The poison contained in the plant acts on the heart muscle, causing a myocarditis with subsequent dilatation of the ventricles. As soon as the process has reached a certain stage the animal dies of 'heart failure'. To the casual observer the disease presents all the characteristics of an infectious disease.

Other no less remarkable diseases were studied by Theiler and his co-workers. A disease called geeldikkop (yellow thick head) in sheep was shown by Theiler (1928) to be due to a plant *Tribulus terrestris,* although more recent work by Quin, Steyn, and others at Onderstepoort has shown that there are other factors to be considered in the causation of this disease.

Vomiting disease of sheep was studied by Du Toit (1928) and proved to be caused by *Geigeria* spp. The disease may produce very severe losses in certain years, especially after droughts, when the plant is very widespread.

The study of poisonous plants is now being actively pursued in various countries, and further interesting developments may be expected. It is obvious that the co-operation of botanists is essential for the success of this work.

*Deficiency Diseases.* The great importance of the vitamins in the nutrition of human beings is so well known that it need not be stressed here. In the case of the common domestic animals (except perhaps the pig, the dog, and the fowl) the vitamins seem to be of far less importance than in human beings. On the other hand, mineral deficiencies are, generally speaking, much more important in animals than in human beings. In recent years it has been found that large portions of the earth's surface are deficient in some mineral or other essential for the normal health and growth of animals.

In South Africa, as well as in other African territories and in Australia, the most serious deficiency is that of phosphorus. Theiler and his co-workers have investigated the ill-effects of this deficiency on cattle very fully. They have shown that cattle grazing on phosphorus-deficient pastures develop a depraved appetite for bones and other carcase debris, and this may lead to the ingestion of toxic material with fatal results (lamsiekte in South Africa); further, that such cattle remain stunted in growth, are late in maturing, are frequently unfertile, produce very little milk, and are very susceptible to various diseases. By the addition of a small daily ration of phosphorus to the diet, they were able to bring about an almost miraculous improvement in the condition of the animals.

As a result of the general feeding of phosphorus compounds in the deficient areas of South Africa, the disease lamsiekte, which a dozen years ago caused enormous losses, has practically disappeared and cattle farming in those areas has again become profitable. The significant fact may be recorded here that the village of Vryburg in Bechuanaland, where ten years ago milk was very scarce, to-day owns a creamery which handles a larger volume of cream than any other creamery in South Africa.

## Other Veterinary Problems.

Problems in connexion with the nutrition of animals are now receiving attention in many countries. The vast importance of correct feeding can be illustrated best by referring again to the phosphorus deficiency which exists in the pastures of South Africa and other countries. The astounding results which have been achieved with the addition of a small quantity of phosphorus compounds to the ration of the animals promise to revolutionise the beef and dairy industries.

Animal breeding also presents problems of great importance and these are intimately bound up with the porblems of disease and nutrition. In South Africa,

as in other countries, there is a constant cry for the replacement of the scrub bull by pedigree sires. This demand would be met to a far greater extent were it not for the fact that in many parts of the country pedigree bulls cannot live because of disease or nutritional difficulties.

In South Africa control over the diseases mentioned above is gradually improving and, in regard to the deficient areas, recent investigations by Du Toit and Bisschop have shown that the grading up of native stock can be carried out with complete success provided the deficient mineral is supplied. Both beef cattle and dairy cattle have been bred on the extremely deficient veld of Bechuanaland without signs of deterioration, and the cost of the supplementary ration has been negligible in comparison with the advantage derived from such feeding.

Gratifying though the success which has been achieved may be, the need for further research on live-stock problems has never been greater than it is to-day. The development of enormous areas in the British Dominions and Colonies is entirely dependent on the progress of research. With the aid of further scientific measures, these new countries could absorb a very much larger population than they now harbour. Over-population will not make itself felt for generations, nor need over-production be contemplated seriously.

The prosperity of a very large percentage of the population, both European and native, in the Dominions and Colonies depends on the live-stock industry—breeding of pedigree stock; beef, mutton, or pork production; dairy farming; wool or mohair production; skin and hide trade; poultry farming, etc. These farmers look to the veterinary service of their countries more and more for assistance and protection. Without this assistance, profitable stock farming, especially in the tropical and sub-tropical countries, is impossible. The assistance, if it is to be effective, must be based on the latest achievements of scientific research. Rule-of-thumb methods will not suffice.

In a humble way South Africa has proved the wisdom of maintaining an adequate veterinary research service. At Onderstepoort the Government twenty-one years ago established what must be regarded as a fairly large research institute, if the size of the population be taken into consideration. This institute, under the brilliant directorship of Sir Arnold Theiler, soon proved to be not a liability but a valuable asset to the country. The results obtained in any one of its various sections would probably have justified the maintenance of the entire institution.

I have said that the Dominions and Colonies have played an important part in the recent growth and development of modern veterinary science. The quality of the research work produced by veterinarians in these countries has been of such high order that it soon placed veterinary science (which not many years ago was regarded as the Cinderella of sciences) abreast of the other sciences. As a matter of fact, in South Africa it can be said, without disparagement to any other group of workers, that veterinary science occupies a very high, if not the leading, position. This

has had a wholesome influence on the science itself and on the type of worker who was recruited in its service. The stigma of inferiority which for so long was attached to the veterinarian has disappeared. To-day, veterinary science is looked upon as a field of work which offers almost unlimited scope for research and, in its practical application, may bring untold material benefit to a country.

# NOTES

## DROUGHT-RESISTANT CANES.

The Hawaiian sugar experiment station has made an investigation of the juices of seven varieties of sugarcane in which the freezing point and osmotic concentration of each of the varieties was determined. On examining the figures it is seen that there appears to be a correlation between the freezing point of the juice and the resistance of the variety to drought. Uba cane is without doubt the most drought-resistant cane variety in Hawaii, and it has the lowest freezing point and highest osmotic concentration of the varieties studied. Lahaina cane, the juice of which is easily frozen and has a low osmotic concentration, is without question very sensitive to drought. [*Facts about Sugar*, September, 1930.]

## COTTON NOTES.

We have received the following for publication from the Secretary, Indian Central Cotton Committee :—

COTTON HAIRS : CHARACTERISTICS.—R. C. Campbell. (*Georgia Experiment Station Bull.* No. 158, 1929, 15 pp.).

Investigations of the relationships between the length weight, volume, tensile strength, and maturity of cotton hairs are described. The results of measurements are tabulated and the relationships between the different characteristics are shown graphically. The results show that the breaking load per hair for the varieties tested increases with the weight per inch of the hair. Generally speaking, mature and well-developed cotton seed hairs are stronger than immature thin-walled hairs. This seems to justify the common statement that the presence of a medium to high percentage of immature hairs in a sample of lint will weaken the tensile strength of the fibre, and to some extent the tensile strength of the yarn. The strength of the yarn, however, will probably be affected very little, if any, by the presence of immature hairs since the same size of yarn would contain more hairs per cross section with a higher percentage of immature hairs. The weight of cotton seed hair per unit length increases with the process of maturity from the date of fertilization to the date on which the bolls open. Increase during the first four weeks is due almost entirely to elongation of cell. During the remainder of the maturation period the increase is due almost entirely to secondary thickening of the cell wall. About two-thirds of the weight of ripe cotton seed hairs is due to secondary thickening of the wall of the hair cells. The cotton hair elongates very little, if any, after about the 30th to 32nd day of maturation. The maximum length is reached sometime

about the 30th day for varieties of which the bolls mature in about 47 to 50 days after the blossom opens. Varieties that have a maturation period of 54 to 58 days require a proportionately longer period for hair elongation. As a general rule, short seed hairs are heavier in proportion to their length than long ones. This indicates that ordinarily long staple cottons have a finer lint than short staple although there are exceptions. [*British Cotton Industry Research Association—Summary of Current Literature*—Vol. X, No. 18.]

PLANT FIBRES : CHEMICAL SECTIONING.—M. A. el Kelaney and G. O. Searle. (*Proc. Roy. Soc.*, 1930, B. 106, 357-363).

A simple method is described for obtaining thin transverse sections of plant fibre bundles by chemical means. The fibre is boiled in sulphuric acid and without washing is then dried in an oven until it begins to char. The tendered fibre is mounted in caustic soda solution and submitted to suitable pressure, whereupon the fibre bundles segment into transverse sections. These sections are usually between $10\mu$ and $20\mu$ thick, quite flat, exactly transverse and retain all the fine details of structure present in the untreated fibre. It is suggested that sections formed in this way will be a valuable aid to the routine identification of different fibres. Tentative suggestions are made as to the underlying cause of fibre segmentation. Sections of six kinds of fibre are illustrated. [*The Journal of the Textile Institute*, Vol. XXI, No. 9].

# Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

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Dr. R. P. Paranjpye, M.A., B.Sc., Member of the Council of India, has been appointed as the representative of India on the Executive Council of the Imperial Agricultural Bureaux, *vice* Dr. D. Clouston, C.I.E., M.A., D.Sc.

*Madras.*

Mr. D. G. Munro, B.Sc., I.A.S., temporarily Oil-Seed Specialist, has been posted as Deputy Director of Agriculture, VIII Circle, Madras Presidency, on relief by Mr. J. S. Patel.

Mr. J. S. Patel has been appointed Oil-Seed Specialist, Madras Presidency, on probation.

Mr. C. Narayana Ayyar, Dip. Agri., District Agricultural Officer, Cuddalore, has been appointed Deputy Director of Agriculture, VII Circle, Madras Presidency, and posted for duty under the Registrar of Co-operative Credit Societies.

Mr. R. C. Broadfoot, N.D.A., C.D.A., I.A.S., Deputy Director of Agriculture, VIII Circle, Madras Presidency, on relief by Mr. D. G. Munro, has been appointed officiating Principal, Agricultural College, Coimbatore.

The services of Mr. P. H. Rama Reddi, M.A., B.Sc. (Edin.), I.A.S., officiating Principal, Agricultural College, Coimbatore, have been placed at the disposal of the Government of India for employment as Deputy Secretary to the Indian Central Cotton Committee, Bombay.

*Bombay.*

Mr. V. A. Tamhane, M.Ag., M. Sc., I.A.S., Agricultural Chemist and Soil Physicist, Agricultural Research Station, Sakrand, has been granted leave on average pay for two months with effect from the 3rd January, 1931, with permission to prefix the Christmas holidays.

MR. N. V. KANITKAR, Assistant Professor of Chemistry, Agricultural College, Poona, doing duty as Soil Physicist to Government, Bombay, has been granted leave on average pay for eight months with effect from the 25th November, 1930.

MR. V. G. PATWARDHAN, Assistant Professor of Chemistry, Agricultural College, Poona, has been appointed to act as Soil Physicist to Government, Bombay.

*United Provinces.*

MR. R. V. DAMLE, B.A., Assistant Professor of Botany, Agricultural College, Cawnpore, has been placed in charge of the duties of the Second Economic Botanist to Government, United Provinces, in addition to his own, with effect from the 28th August, 1930.

MR. S. C. ROY, M.Sc. (Alld.), B.Sc. (Lond.), has been appointed temporary Professor of Botany at the Agricultural College, Cawnpore, from the date of assuming charge of his duties.

MR. W. HEAD has been confirmed in the post of Deputy Director of Gardens, United Provinces, with effect from the 4th January, 1930, *vice* Mr. A. E. P. Griessen, retired.

*Punjab.*

MR. T. A. MILLER BROWNLIE, C.E., M.I.W.E., M.I.M. and C.E., Agricultural Engineer to Government, Punjab, Lyallpur, has been appointed as Principal, Punjab Agricultural College, Lyallpur, with effect from the 16th September, 1930, in addition to his own duties and relieving Dr. P. E. Lander, Agricultural Chemist to Government, Punjab, of the additional charge.

MR. W. TAYLOR, I.V.S., M.R.C.V.S., D.V.H., Principal, Veterinary College, Lahore, has been appointed to officiate as Director, Imperial Institute of Veterinary Research for six months from the 3rd October, 1930, *vice* Mr. F. Ware, F.R.C.V.S., I.V.S., on leave.

CAPTAIN U. W. F. WALKER, M.C., I.V.S., M.R.C.V.S., Professor of Surgery at the Punjab Veterinary College, Lahore, has been appointed to officiate as Principal, Punjab Veterinary College, Lahore, with effect from the 22nd September, 1930.

LALA DURGA DASS, G.P.V.C., P.V.S., Assistant to the Professor of Medicine, Punjab Veterinary College, Lahore, has been appointed to perform the duties of the post of Professor of Medicine, Punjab Veterinary College, Lahore, with effect from the 22nd September, 1930.

### *Burma.*

MR. G. PFAFF, M.R.C.V.S., has been appointed to the Burma Veterinary Service, Class I, with effect from the 29th September, 1930. Mr. Pfaff has been appointed Principal of the Veterinary College, Insein, in place of Mr. S. R. Rippon, and to officiate as Veterinary Research Officer, with headquarters at Insein.

The headquarters of MR. S. R. RIPPON, M.R.C.V.S., I.V.S., Deputy Director of Veterinary Services, South-Eastern Circle, and officiating Deputy Director of Veterinary Services, South-Western Circle, Burma, have been transferred from Insein to Moulmein.

On return from leave, MR. H. F. ROBERTSON, B.Sc., I.A.S., has been re-posted to Mandalay as Professor of Agriculture, Agricultural College, Mandalay.

On return from leave, Mr. F. D. ODELL, M.A., I.A.S., has been re-posted as Deputy Director of Agriculture, West Central Circle, Burma, with headquarters at Magwe.

On return from leave, Mr. A. MCLEAN, B.Sc., I.A.S., has been re-posted as Deputy Director of Agriculture, East Central Circle, Burma, with headquarters at Pyinmana, *vice* Mr. R. Watson who remains in charge of the Myingyan Circle.

### *Bihar and Orissa.*

MR. A. P. CLIFF, B.A., I.A.S., Deputy Director of Agriculture, Bihar and Orissa, has been posted, on expiry of his leave, to the North Bihar Range with headquarters at Muzaffarpur.

MR. C. A. MACLEAN, M.C., M.A., B.Sc., I.A.S., Deputy Director of Agriculture, Bihar and Orissa, has been posted, on expiry of his leave, to the Chota Nagpur Range.

*Central Provinces.*

On return from leave, Mr. F. J. PLYMEN, C.I.E., I.A.S., has been re-posted as Director of Agriculture, Central Provinces.

On relief by Mr. F. J. Plymen, Mr. R. G. ALLAN, M.A. (Cantab.), I.A.S., officiating Director of Agriculture, Central Provinces, has reverted to his substantive post of Principal, Agricultural College, Nagpur, and has been placed, in addition to his own duties, on special duty in connection with the enquiry on past manurial experiments.

On relief by Mr. R. G. Allan, Mr. E. A. H. CHURCHILL, B.Sc. (Edin.), I.A.S., officiating Principal, Agricultural College, Nagpur, has been posted as Deputy Director of Agriculture, Northern Circle, Central Provinces.

On relief by Mr. E. A. H. Churchill, RAI SAHIB BHAIYA LAL DUBEY, L.Ag., Deputy Director of Agriculture, Northern Circle, Central Provinces, has been posted to the charge of the North-Western and Plateau Circle, Hoshangabad.

*Assam*

On the termination of his special duty in the Assam Secretariat, Mr. I. MAJID, I.C.S., has been appointed to officiate as Director of Agriculture and Industries and Registrar of Co-operative Societies, Assam.

*Baluchistan.*

NAWABZADA SAADATULLAH KHAN, M.A., Barrister-at-Law, I.A.S., on transfer from Madras, has been appointed Agricultural Officer in Baluchistan with effect from the 7th August, 1930.

# NEW BOOKS

## On Agriculture and Allied Subjects

1. Principles of Farm Mechanics, by M. A. Sharp and W. M. Sharp. Pp. xx+269. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) Price, 15*s*. net.
2. Size and Form in Plants: with special reference to the Primary Conducting Tracts, by F. O. Bower Pp. xiv + 232. (London: Macmillan & Co.) Price, 12*s*. 6*d*. net.
3. Manual of Bacterial Plant Pathogenes, by Charlotte Elliott. Pp. ix + 349. (London: Baillière, Tindall & Cox.) Price, 22*s*. 6*d*. net.
4. Poultry Husbandry, by A. Morley Jull. Pp. ix + 639. (London: McGraw-Hill Publishing Co., Ltd.) Price, 20*s*. net.
5. The use of Iodine and its Compounds in Veterinary Practice, by Lieut.-Col. H. A. Reid Pp. 88. (London: De Gruchy & Co., Ltd.) Price, 3*s*. 6*d*.
6. Rusticus Loquitur or the Old Light and the New in the Punjab Village, by M. L. Darling. Pp. xiv + 400. (Oxford University Press.) Price, 15*s*. net.
7. A Handbook for Cane-Sugar Manufacturers and their Chemists, by the late Dr. Guilford L. Spencer. Seventh Edition, revised, re-written, and enlarged by George P. Meade. Pp. xix + 560. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) Price, 30*s*. net.
8. Reports on the Work of Agricultural Research Institutes and on certain other Agricultural Investigations in the United Kingdom 1928-29. pp. 248. Issued by the Ministry of Agriculture and Fisheries Department of Agriculture for Scotland and Ministry of Agriculture for Northern Ireland. (London: His Majesty's Stationery Office.) Price, 1*s*. net.
9. Report of the Conference on Cotton Growing Problems, 1930. (London: Empire Cotton Growing Corporation.) Price, 2*s*. 6*d*.
10. Index to the Literature of Food Investigation, Vol. 2, No. 1, March 1930, compiled by Agnes E. Glennie. Pp. iv + 108. Issued by the Department of Scientific and Industrial Research. (London: His Majesty's Stationery Office.) Price, 2*s*. net.
11. Report of the Third Imperial Entomological Conference, 17-27th June 1930. Pp. 59. (London: Imperial Institute of Entomology.) Price, 2*s*. net.

The following publications have been issued by the Imperial Department of Agriculture since our last issue :—

*Memoir.*

1. The Inheritance of characters in Rice, Part III, by K. Ramiah, L.Ag., M.Sc., Dip. Agri. (Botanical Series, Vol. XVIII, No. 7.) Price, As. 14 or 1*s*. 6*d*.

*Catalogue of Indian Insects.*

2. Gyrinoidea, by Georg Ochs (Part 19). Price, As. 12 or 1*s*. 3*d*.

## APPENDIX.

## INSTRUCTIONS TO AUTHORS OF PUBLICATIONS OF THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

1. All manuscripts should be clean, clear and carefully revised. Only one side of the paper should be used, and as far as practicable the original type-written copy and not a carbon copy should be sent. Capitals should be sparingly used, and all the necessary punctuation should be done in the MS. and not left for introduction in proofs.

2. The title of a paper should not be lengthy.

3. It is desirable that the MS. should have suitable heads and sub-heads. In numbering the principal divisions of a paper roman numerals should be used. The use of arabic figures and (*a*), (*b*), (*c*), etc., is generally reserved for numbering the sub-divisions coming under each head.

4. Articles submitted for publication either in the "Indian Journal of Agricultural Science" or in the "Indian Journal of Veterinary Science and Animal Husbandry" should be accompanied by abstracts for publication in "Agriculture and Live-stock in India." Abstracts should be concise, but should be long enough to explain the matter dealt with ; ordinarily no abstract should exceed 200 words.

5. When a word or line is intended to be printed in *italics* it should be underlined with a single line, in SM. CAP. with two lines, in CAPITALS with three lines and when in **antique** (heavy type) with a wavy line ( - ).

6. In descriptive matter, numbers under 100 and all numbers occurring at the beginning of a sentence should be in words.

7. Local names for crops, technical operations, etc., should be defined where they first occur in the text, *e.g.*, *rabi* (spring crop). The use of local weights and measures should be avoided as far as possible. Vernacular names, such as *jowar*, *bajri*, should be in italics without a capital letter, and each such name where it first occurs should be followed by its scientific equivalent in brackets, *e.g.*, *jowar* (*Andropogon Sorghum*). It is usual to write the initial letters of varietal names in capitals, *e.g.*, Striped Mauritius, Dharwar-American cotton and Broach cotton.

8. Botanical and zoological names are printed in italics and should be underlined in the MS., *e.g.*, *Triticum vulgare* L., *Diplodia Corchori* Syd., *Pyrilla aberrans*, Kirby. The International rules of Botanical nomenclature and the International rules of Zoological nomenclature should be followed. The names of chemical substances should not be written with a capital letter ; they are printed in roman type (*e.g.*, calcium carbonate, prussic acid).

9. The following and similar abbreviations may be used freely :—*viz.*, *e.g.*, *i.e.*, mm. (millimetre), cm. (centimetre), grm. (gramme), mg. (milligramme), c. c. (cubic centimetre), sp. gr. (specific gravity), lb. (pound), cwt. (hundredweight), in. (inch), ft. (foot), oz. (ounce), md. (maund), sr. (seer), ch. (chattack). Other abbreviations should be used sparingly, if at all.

10. References to plates should be given within brackets, without prefixing the word " see " or "cf.", in the MS. itself, and should not be left over for introduction in proofs. For example, " The parasite (Pl. X, fig. 4) was present late in 1906."

11. The word " Table " is preferable to " Statement," and tables should be numbered consecutively in roman figures. Each table should have an explanation as a sub-head. It is more convenient for reference if tables can be printed horizontally ; for this purpose they should not exceed in width the printing measure of the page (5"). *Example*—

TABLE IV.

*Results of water-saving experiments on wheat (Pusa 12) at Gungapur, Haripur and Sargodha, 1916-17.*

| Station | No. of irrigations including the preliminary watering | YIELD PER ACRE IN MAUNDS AND SEERS | | | | AVERAGE YIELD PER ACRE | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Grain | | Straw | | Grain | | Straw | |
| | | mds. | srs. | mds. | srs. | mds. | srs. | mds. | srs. |
| Gungapur . . | One | 12 | 19½ | 20 | 10 | | | | |
| Haripur . . | ,, | 8 | 31 | 19 | 14 | 9 | 34 | 21 | 17 |
| Sargodha . . | ,, | 8 | 12½ | 25 | 27½ | | | | |

12. References to literature, arranged alphabetically according to authors' names, should be placed at the end of the article, the various references to each author being arranged chronologically. Each reference should contain the name of the author, the year of publication, the abbreviated title of the publication, volume and page. In the text the reference should be indicated by the author's name followed by the year of publication enclosed in brackets ; when the author's name occurs in the text, the year of publication only need be given in brackets. If reference is made to several articles published by one author in a single year, these should be numbered in sequence and the number quoted after the year both in the text and in the collected

references. This system of referencing is used in the "Biochemical Journal" and will be clear from the following illustration :—

The work of Osborne and Mendel [1919, 1, 2] and Steenbock and Boutwell [1919] had indicated an association of the fat-soluble vitamin with the green parts of plants. This view was examined by Coward and Drummond [1921], who reported that vitamin A was not synthesised by etiolated shoots but that green leaves were active in its formation. Another worker [Wilson, 1922], on the other hand, found that etiolated shoots if given in sufficient quantity could supply the fat-soluble vitamin and that this factor was therefore formed in the absence of light.

REFERENCES.

Coward and Drummond (1921). *Biochem. J.* **15**, 530.
Osborne and Mendel (1919, 1). *J. Biol. Chem.* **37**, 187.
——————— (1919, 2). *J. Biol. Chem.* **41**, 549.
Steenbock and Boutwell (1919). *J. Biol. Chem.* **41**, 149.
Wilson (1922). *J. Biol. Chem.* **51**, 455.

Abbreviations, as far as possible, should follow the system adopted in "A World List of Scientific Periodicals" published by the Oxford University Press.

13. Papers should be complete when submitted for publication. As alterations and additions at the proof stage cause both additional expense and delay, they should be resorted to as little as possible. In making corrections in proofs the recognized symbols which will be found in the "Standard Dictionary" should be used. Second (page) proofs will be submitted to authors who should return them promptly.

### Illustrations.

14. As the *format* of the journals has been standardized, the size adopted being crown quarto (about $7\frac{1}{8}'' \times 9\frac{5}{8}''$ cut), no text-figure, when printed, should exceed $4\frac{1}{2} \times 5$ inches. Figures for plates should be so planned as to fill a crown quarto plate—the maximum space available for figures being $5\frac{3}{4} \times 8$ inches exclusive of that for letterpress printing.

15. Photos or drawings for illustration should accompany the manuscript and each should bear on the reverse side the name of the paper to which it relates together with the title or legend, figure or plate number, and the size to be reproduced. When giving instructions for reduction linear measurements are understood; thus, "half-size" means reduce to half the length and breadth, not half the area. A photograph should not be rolled up, nor pinned, and should always be packed flat. A complete list of plates and figures should always accompany the paper.

16. Line drawings should be made with clear black lines on smooth white paper, preferably Bristol board. Rough paper should be avoided. Care should be taken that all the lines are drawn firmly; scratchy or grey lines, produced by the ink being thinned down, are not permissible. Drawings should be larger than the

required size. All lettering should be neatly and clearly put in, care being taken to make all lettering sufficiently large to stand reduction.

17. For half-tone work, copy should be made on glossy silver paper and of the same size or larger than the size required.

18. For three-colour work, copy may be oil painting, water-colour, coloured photograph or coloured transparency, and larger than the size required. In preparing copy, one should use only the primary colours, in any combination, as only inks of primary colours are used in printing. Originals can be enlarged, if necessary, but this should be avoided if possible.

19. For detailed instructions regarding preparation of illustrations, it would be of advantage to refer to Mr. C. M. Hutchinson's article on "Photographic Illustrations" in the *Agricultural Journal of India*, Vol. XI, Pt. 3, July 1916, and Mr. A. W. Slater's paper on "The Preparation and Reproduction of Scientific Illustrations" in the *Proceedings of the Third Entomological Meeting*, 1919, which has been reprinted as *Bulletin No. 114 of the Agricultural Research Institute, Pusa.*

MGIPC—S1—III-1-62—12-2-31—2,000.

# ORIGINAL ARTICLES

## INTERNATIONAL AND IMPERIAL CO-OPERATION IN REGARD TO AGRICULTURAL STATISTICS AND THE COMPILATION AND DISSEMINATION OF SCIENTIFIC AND TECHNICAL INFORMATION.*

BY

**DEWAN BAHADUR SIR T. VIJAYARAGHAVACHARYA, K.B.E.,**

*Vice-Chairman, Imperial Council of Agricultural Research.*

IT is at once a pleasure and a privilege to welcome you to the Agricultural Section at the 18th annual meeting of the Indian Science Congress. I propose to depart somewhat from precedent, for, instead of choosing for my address a subject connected with some special branch of agricultural science, I have selected one of a somewhat more general nature which, however, is closely concerned with the successful application of science to the improvement of agricultural practice. Agricultural statistics form the basis of studies in the economics of agriculture, whilst the rapid dissemination of scientific, technical and statistical information is becoming more and more important in these days of specialisation. The recent depression in agriculture due to the fall in prices of agricultural produce clearly brings out two points which bear on the subject of my address. Never was there a greater need for improvement in the *efficiency* of agricultural production than at present, since low prices can only be permanently combated by this means. In promoting such an increase in efficiency the rapid dissemination of scientific and technical information is an important factor. The present world crisis in agriculture has also brought out clearly the interdependence of different countries on each other and the need for much more accurate statistics of the production and consumption of agricultural commodities than exist at present. The pro lem is largely an international one and I have recently had an opportunity of visiting the International Institute of Agriculture and of representing India at the biennial meeting of its General Assembly, where these problems were discussed from the international aspect.

As most of you are aware, the International Institute of Agriculture was founded 25 years ago largely through the energy and foresight of an American citizen, David Lubin, whose eloquence secured the assistance of His Majesty the

*Presidential Address to the Agricultural Section, Indian Science Congress, Nagpur, January 1931.

King of Italy and the foundation of the Institute at Rome. The Institute is supported by subscriptions from most of the Governments of the world, and India has been a contributing country since the inception of the Institute. From an early stage in its history, the Institute devoted special attention to international agricultural statistics and for many years published an invaluable international yearbook of agricultural statistics and a monthly statistical bulletin. In these publications the Institute's statisticians summarise the world position in regard to the production and consumption of the more important agricultural commodities so far as such information can be obtained. There are many gaps in our knowledge of these matters; the extent to which different countries maintain statistics of agricultural production varies greatly and the systems on which they are maintained vary almost as much, so that the collating of international figures is a task of no small difficulty. The International Institute has recently succeeded in organising a special census of agricultural production which has been carried out throughout the world the results of which are now being compiled. The Institute will now work up the relative economic data which the survey has made available and see what general deductions are possible which will be a guide to agricultural problems in the future. The discussions at the recent meeting of the Assembly show that all countries attach great importance to more thorough studies of the production and consumption of agricultural commodities and the trend of future changes. Only as our knowledge of these matters increases, can we hope to so regulate policy that sudden changes as these, which have lately disturbed the world, can be avoided.

At the recent General Assembly at Rome, while universal appreciation was expressed of the valuable statistical work conducted by the Institute, in some important quarters doubts were thrown on the suitability of its machinery for dissemination and interchange of scientific information relating to the different branches of agriculture. There is no single science of agriculture; on the contrary, the application of scientific methods to the solution of agricultural problems makes demands practically on all branches of science. But if agriculture makes demands on all branches of science, it also has to be recognised that many of the problems involved lie on the border-line of those sciences, and, in these days of specialisation in scientific research, it is becoming more and more difficult for the scientific investigator to keep in touch with progress even in his own and allied subjects. The investigator of agricultural problems feels difficulty the more acutely because the ground to be covered, if he attempts to read all the available literature, is so wide, both because of the number of sciences involved and because his problems are nearly always border-line problems. New advances in pure science are constantly making possible new methods of approach and entirely new technique in

applied science; and the agricultural investigator needs to be kept in touch with such developments. At the Imperial Agricultural Conference of 1927, the need of agricultural investigators throughout the Empire for the systematic supply of scientific information bearing on the work was strongly emphasised. As a result, a scheme of Imperial Agricultural Bureaux was drawn up and arrangements made for it to be financed partly by the British Government and partly by each of the countries of tho Empire. Eight Bureaux are now in working order and are controlled by an executive committee on which each country is represented. In order that research workers abroad might obtain the utmost possible assistance and that research institutions in England might be brought into touch with the needs of other portions of the Empire, each Bureau was located at a centre of research in the special subject dealt with. Thus the Imperial Bureau of Soil Science has been placed at the famous Rothamsted Experiment Station. The Imperial Bureau of Plant Genetics (for crops other than herbage) has been placed at Cambridge and associated with the School of Agriculture, whilst the Imperial Bureau of Plant Genetics for herbage plants has been placed at Aberystwyth where so much valuable work on fodder crops and grasses has already been conducted. The Imperial Bureau of Fruit Production is situated at the East Malling Fruit Research Institute in Kent. The Imperial Bureau of Animal Nutrition is located at the well-known Rowett Institute at Aberdeen, that of Animal Health at the Veterinary Laboratory, Weybridge, that of Animal Genetics in the University of Edinburgh, whilst the Imperial Bureau of Agricultural Parasitology has found a home at St. Albans. It will be observed that these Bureaux together with the older institutions—the Imperial Bureau of Mycology at Kew and the Imperial Bureau of Entomology, now the Imperial Institute of Entomology—cover most branches of agricultural science. Their functions are to collect, collate, abstract and distribute to all research workers desiring such assistance, the results of recent research in the subject with which the Bureau deals. Already several valuable bibliographies and summaries of current research in several subjects have recently been issued. The work is essentially co-operative. Only in so far as other countries in the Empire provide the Bureaux with copies of published papers and other information, can the Bureaux maintain the supply of information to workers in other parts of the Empire. In each country there is an official correspondent for each Bureau. For India the official correspondents are the two Expert Advisers to the Imperial Council of Agricultural Research. I would take this opportunity of asking all research workers in agriculture and the allied sciences to assist the Research Council in supplying the Bureaux with complete sets of Indian publications. The Bureaux have a still more important,

if less definite, function than the publication of bibliographies and abstracts, *viz.*, to assist individual research workers to obtain information as to how matters stand in any particular branch of investigation and to put them in touch with specialists in other countries. The Bureaux have skilled translators and are thus able to make available papers which are not easily accessible. One Bureau—the Imperial Bureau of Plant Genetics, Herbage Plants—in particular has established a small loan library of translated papers which can be lent to other research workers in need of such assistance. Though official correspondents have been appointed, it is the essence of the scheme that individual research workers should correspond freely with the Bureaux on matters of scientific interest. I have recently had the privilege of visiting all these Bureaux except that at Aberystwyth and am fully satisfied both that India can make and is making a substantial contribution to the advancement of agricultural science and that all parts of the Empire stand to gain by the pooling of knowledge now rendered possible. The funds for the maintenance of these Bureaux are supplied mainly by the ritish Government, the contributions from the Dominions including India being small in proportion, while on the Executive Council, which is the governing body of the Bureaux, the Dominions have an equal voice with Great Britain. Coming nearer home, the Imperial Council of Agricultural Research has recently decided to establish a Bureau of Agricultural Information for India. Not only will this provide a liaison with the Imperial Bureaux already mentioned, but it is hoped that it will also assist research workers in India in the various branches of agriculture to keep in touch with each other and with work in progress in other parts of the country. The Imperial Council of Agricultural Research is charged both with the promotion of research and the dissemination of information; it is hoped that its latest venture will be successful in the latter direction.

# REVIEW OF SOME BREEDING EXPERIMENTS CARRIED OUT AT THE U. P. POULTRY ASSOCIATION'S DEMONSTRATION FARM, LUCKNOW.

BY

MRS. A. K. FAWKES,

*Secretary, United Provinces Poultry Association.*

The primary need for an egg-producing breed of fowl that will be more immune to the Indian climate and conditions than imported poultry are, has led the Association to conduct experiments to endeavour to discover such a breed.

After following up some experiments in crossing Chittagong hens with Rhode Island Red males, the experiment was relinquished owing to two drawbacks—(1) the prevalence of broodiness in the progeny, (2) the pugilistic tendencies of the progeny who from chickenhood fought so constantly that the area of land required for rearing them satisfactorily was not available. Otherwise the progeny were fine birds and fair layers.

A further experiment has been made in crossing local hens with high-producing Leghorn males; these experiments are still going on, but they do not seem to indicate any remarkable improvement in the egg yield of the progeny. Individual high records have been obtained but flock averages do not tend to indicate that Indian village hens mated to pure bred males will produce a definite increase in egg yield, the dominant zero breeding factor of the Indian hen nullifying the attainment of better flock production in the progeny. In all other respects the improvement is marked.

We realized that to obtain satisfactory results we must look for an indigenous breed of which the females were already good layers. We happened to come in touch with a breed of hens in Western India commonly known as Bussorah or Busra fowls. These birds are fairly common around Bombay and are imported evidently from the Persian Gulf.

In 1926, we purchased four hens of this breed from Bombay, and trapnested them, and on p. 115 is appended a record for four years of their winter laying.

One hen met with an accident and had to be destroyed in 1928; the other three hens (now 5 and 6 years old) are still with us and laying 30 eggs or so during the winter months.

The Busra hen is a bird typically built for egg production. A deep bodied bird, light in feather, alert, and though smaller than a Leghorn in appearance, weighs 4½ lbs. as a pullet. The breed is distinguishable by its semi-buttercup comb, grey legs, and a tuft of feathers on the head. The colour varies, and requires stabilising, but the main characteristics of type are apparent in all colours. The egg is a large white egg, in many cases reaching the two ozs. standard. Broodiness is not so troublesome as in country hens. The broody period is easily broken, and within a few days the hen returns to lay.

This breed therefore seemed to us worth cultivation. We therefore trapnested the original Busra hens, and the record is given in Table I.

The following year we experimented in crossing these pure Busra hens with a White Leghorn male.

The eggs hatched well under artifical methods, and the chicken were reared most easily, showing rapid growth, little or no mortality, and showed immunity to hot season conditions. We therefore selected a group of pullets and trapnested them during the winter season (the period recognised by poultry breeders as determining the future laying powers of pullets), and the results of our first cross experiments carried out in three successive winters are given in Table II.

The results were most satisfactory, especially as regards broodiness. This factor was practically eliminated by the introduction of the non-broody White Leghorn strain.

Egg production and the size of the egg were remarkable.

In 1928-29, we further experimented with crossing our half Busra×Leghorn pullets back to a pure White Leghorn male. We append the egg records (Table III) which, though still good, were not quite so high as in the first cross, but part of the results were lost by distributing the stock to a village where no records could be kept.

The appearance of this cross closely resembled the White Leghorn parent.

The experiment was continued in 1929-30, and a third cross was made between the ¾ Busra×Leghorn pullets and a pure White Leghorn male, of which the record is given in Table IV. At the same time we continued to keep the Busra strain intact. In order to do this we imported a Busra or Bussorah cock from the Persian Gulf and mated him to our original hens.

We have carefully recorded results, and the progeny are fine birds, but show an increase of broodiness in the progeny, due doubtless to the influence of the pure Busra male of whose parentage we had no record.

Seven of the pullets of this mating were sent in 1929 to the National Laying Test, Milford, England, where they are now in competition with some three to four thousand pure pedigreed birds from all countries.

The results of their laying for 48 weeks are given in Table V. Breeders in the West have been immensely interested in their performance and in their wonderful vitality and stamina. In spite of snow and rain not one bird has been sick or sorry.

Their curious propensity to go broody at intervals for a few days only and then return to lay has been the factor that has marred their otherwise fine performance. This propensity is only a matter of experiment to breed out. The interesting fact is that this untried unpedigreed breed from India has put up in Europe a very fine record, especially hens numbered 457 and 461. The former, by one egg only, failed to get the copper ring award, the hall-mark of a recognised high producer.

In the field, that is to say in our distribution of eggs and birds to United Provinces villages, the Busra×Leghorn cross has given satisfaction, and we are getting a great demand for all the stock that we can produce.

We hope to continue to breed these birds and would recommend all poultry breeding centres to indent on us for eggs and so procure a large supply of these fowls making them available to the smaller poultry breeders throughout India.

Concerted action ought to be taken to raise large supplies of such a useful variety.

TABLE I.

*Four years' winter egg record of pure Busra hens on Lucknow Farm.*

| —— | Nov. | Dec. | Jan. | Feb. | Total | Average per hen | Remarks |
|---|---|---|---|---|---|---|---|
| *1926-27—4 hens in pen.* | | | | | | | |
| Total monthly . . | ... | 60 | 89 | 80 | 229 | 57·1 | |
| *1927-28—4 hens in pen.* | | | | | | | |
| Total monthly . . | 27 | 61 | 59 | 76 | 223 | 55·3 | One hen accidentally killed during 1928. |
| *1928-29—3 hens in pen.* | | | | | | | |
| Total monthly . . | 52 | 33 | 54 | 24 | 163 | 54·1 | |
| *1929-30—3 hens in pen.* | | | | | | | |
| Total monthly . . | 9 | 24 | 16 | 44 | 98 | 32·2 | |

**Hens are now 5 years old and still laying.**

## TABLE II.

*Three years' winter egg record of First Cross (Busra × White Leghorn Cock)* (i.e., *four months winter trapnest record.*)

| — | Nov. | Dec. | Jan. | Feb. | Total | Average per hen |
|---|---|---|---|---|---|---|
| *1927-28—7 hens in pen.* | | | | | | |
| Total monthly . . | 85 | 151 | 156 | 137 | 529 | 75·4 |
| *1928-29—9 hens in pen.* | | | | | | |
| Total monthly . . | 151 | 136 | 146 | 141 | 574 | 63·7 |
| *1929-30—8 hens in pen (1 death.)* | | | | | | |
| Total monthly . . | 60 | 126 | 130 | 120 | 436 | 54·4 |

*One year egg-laying record of Busra × White Leghorn First Cross at the United Provinces Poultry Association Egg-Laying Test*, i.e., *from 1st November 1927 to 30th September 1928, 12 lunar months.*

| Hen. Reg. No. | Nov. | Dec. | Jan. | Feb. | Mar | Apr. | May | June | July | Aug. | Sep. | Grade | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 1st | 2nd | |
| 44 | 6 | 17 | 24 | 22 | 21 | 14 | 6 | 12 | 8 | 11 | 9 | 45 | 105 | 150 |
| 45 | 9 | 24 | 25 | 22 | 25 | 12 | 3 | 13 | 17 | 3 | 9 | 47 | 115 | 162 |
| 46 | 17 | 25 | 23 | 20 | 18 | 17 | 6 | 6 | 13 | 13 | 5 | 39 | 124 | 163 |
| 47 | 14 | 25 | 23 | 21 | 22 | 16 | 10 | 12 | 18 | 8 | 14 | 64 | 119 | 183 |
| 48 | 19 | 23 | 23 | 20 | 21 | 19 | 5 | 13 | 17 | 13 | 7 | 55 | 125 | 180 |
| 49 | 6 | 17 | 17 | 15 | 17 | 9 | 6 | 5 | 16 | 6 | 5 | 85 | 84 | 119 |
| 50 | 14 | 20 | 21 | 18 | 22 | 11 | 9 | 9 | 10 | 5 | ... | 28 | 111 | 139 |

## TABLE III.

*Two years' winter record of the progeny of Second Cross (Busra hens × White Leghorn male × White Leghorn male).*

| — | Nov. | Dec. | Total | Average per bird | Remarks |
|---|---|---|---|---|---|
| *1928-29—14 hens in pen.* | | | | For 2 months | |
| Total monthly . . | 227 | 252 | 479 | 34·3<br>Therefore for 4 months.<br>68·6 | These hens were sent to a village and their records lost to the farm. |

| — | Nov. | Dec. | Jan. | Feb. | Total | Average per hen | Remarks |
|---|---|---|---|---|---|---|---|
| *1929-30—5 hens in pen.* | | | | | | | |
| Total monthly . . | 65 | 78 | 75 | 65 | 283 | 56·3 | |

## TABLE IV.

*Four months' winter egg record of the progeny of Third Cross (Busra × White Leghorn × White Leghorn × White Leghorn male).*

| — | Nov. | Dec | Jan. | Feb. | Total | Average per hen | Remarks |
|---|---|---|---|---|---|---|---|
| *1929-30—8 hens in pen.* | | | | | | | |
| Total monthly . . | 89 | 152 | 160 | 151 | 552 | 69 | |

### TABLE V.

*Results of seven Busra hens sent to the National Egg-Laying Test, England. (The test record for 336 days of 12 lunar months, i.e., 48 weeks.)*

| Reg. No. of hen | Total eggs laid | 1st grade | 2nd grade |
|---|---|---|---|
| 456 | 143 | 77 | 66 |
| 457 | 173 | 124 | 49 |
| 458 | 157 | 34 | 123 |
| 459 | 78 | 1 | 77 |
| 460 | 141 | 104 | 37 |
| 461 | 179 | 170 | 9 |
| 462 | 169 | 97 | 72 |
| Total . | 1,040 | | |

# A NOTE ON SOILS REGARDING THEIR SUITABILITY FOR MAKING IRRIGATION ENGINEERING WORKS EXPOSED TO WATER.

BY

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## INTRODUCTORY.

Early in 1930 an investigation of soils regarding their suitability for making bunds, liability to ravining or otherwise, etc., was undertaken at the request of the Superintending Engineer, Southern Irrigation Circle, Burma. In actual practice it has been found that soils called *kyatti* (sticky) by Burmese cultivators are very liable to give bunds in which holes or caverns appear and/or which ravine badly under rainfall. Many such *kyatti* soils can be picked out with fair certainty by appearance but opinions sometimes differ, more especially as *kyatti* soils, although usually yellow-brown in colour, exist as white and red soils also. The problem was to find a quick, simple and reliable test to pick out such soils with certainty and, if possible, to place them in a rough order of merit.

## EXPERIMENTAL.

The first test was carried out on a soil from Myittha (Laboratory No. B 79). This was described as a *kyatti* soil by the Public Works Department officer who supplied it. Chemical and mechanical analyses were carried out without bringing anything useful to light. A selection of the data obtained is given in Tables I and II.

### TABLE I.

*Mechanical analysis of Kyatti-mye* (i.e., *sticky soil*).

| | Per cent. |
|---|---|
| Coarse sand (2·0 mm.—0·2 mm.) | 1·73 |
| Fine sand (0·2 mm.—0·02 mm.) | 22·43 |
| Silt (0·02 mm.—0·002 mm.) | 29·60 |
| Clay (< 0·002 mm.) | 39·53 |
| Moisture | 4·69 |
| $CaCO_3$ | 0·69 |
| Difference | 1·33 |
| | 100·00 |

The above data are on the Atterberg scale with a settling velocity for clay =10·0 cm. in 8 hours at 20° C. There is nothing at all special in this mechanical

analysis, the soil apparently being a quite ordinary stiff calcareous clay, very similar indeed to the Mandalay farm surface soil which is not a *kyatti* soil.

### Table II.

*Chemical and physical data—Kyatti-mye.*

| | Per cent |
|---|---|
| 1. Loss on ignition | 3·87 |
| 2. Organic carbon | 0·17 |
| 3. pH | 8·05 |
| 4. Water-soluble salts | practically *nil.* |
| 5. Total per cent $H_2O$ at sticky point | 32 44 |
| (Cf. Mandalay Farm surface soil | 30·00) |
| 6. Tensile strength at sticky point | 2·93 lbs. per □″ |
| (Cf. Mandalay farm surface soil | 1 47 „ „ □″) |

The Mandalay farm soil contains 40 per cent. clay and is slightly calcareous, containing about 1 per cent. $CaCO_3$. Hence this sample from Myittha appeared to be quite as normal as the Mandalay farm soil which is certainly not a *kyatti* soil in the surface layer.

It was thereupon decided to pursue further the question of the tensile strength of clay/water pastes at the sticky point. A selection of soils both calcareous and non-calcareous and containing from 10-60 per cent. clay was made, the tensile strength of each being determined. At least six determinations of each were made. The results are given in Table III.

### Table III.

*Tensile strength of clay/water pastes at the sticky point.*

A.—Calcareous soils—Mandalay Area.

| No. | Clay per cent. | $CO_2$ (in carbonate form) per cent. | Tensile strength (lbs per □″) | | |
|---|---|---|---|---|---|
| | | | Minimum | Maximum | Mean |
| M26 | 10·5 | 1·04 | 0·42 | 0·67 | 0·54 (6) |
| M17 | 19·3 | 5·29 | 0·47 | 0·55 | 0·50 (6) |
| M27 | 31·4 | 3 4 | 0·57 | 0·96 | 0 81 (6) |
| Central farm | 40·0 | 0·40 | 1·41 | 1·74 | 1·47 (6) |
| M10 | 57·4 | 2·38 | 0·83 | 2·36 | 1·57 (10) |

B.—Non-calcareous soils—Pegu District.

| No. | Clay per cent. | $CO_2$ (in carbonate form) per cent. | TENSILE STRENGTH (LBS. □") | | |
|---|---|---|---|---|---|
| | | | Minimum | Maximum | Mean |
| 4 | 9·6 | .. | 0·47 | 0·68 | 0·59 (6) |
| 3A | 20·4 | .. | 0·91 | 1·22 | 1·05 (6) |
| 12A | 30·3 | .. | 1·78 | 2·56 | 2·22 (6) |
| 23A | 41·6 | .. | 2·18 | 2·64 | 2·46 (7) |

[The number of determinations made on each soil is shown in brackets.]

The results were very variable, time being an important factor. Also the more certain samples were worked by the hand, the higher the tensile strength obtained. In general, however, it appears clear that the presence of carbonates lowers the tensile strength of clay/water pastes at the sticky point.

It should, of course, be remembered that it is by no means an easy matter to measure the tensile strength of a clay paste with anything like accuracy. In general the most striking feature of clays is their plasticity and no single determination measures the plasticity. Usually the estimation made measures two or three properties to varying extents, *e.g.*, cohesion, tensile strength, deformability, etc. The above determinations suffer from this disability and are merely the practical results obtained in measuring the strength of a cylinder of one square inch cross section.

Since the vast majority of soils in the dry zone are calcareous, it is obvious that determinations of tensile strength would be of very little help even if only because of the varying results obtained with any given soil.

Fortunately at this time a further selection of *kyatti* soils came into my possession, and it became obvious that sample No. B79 was not a true *kyatti* soil at all, or at least it was only moderately bad. In Table II it will be seen that the organic carbon was decidedly low, and the loss on ignition is likewise low for such a heavy soil. The sample is, therefore, probably from a considerable depth below the surface, but since, as was subsequently found, *kyatti* soils are a result of the action of soil alkali, the pH being 8·05 only, it was concluded that this soil is a normal soil and is incorrectly described as a *kyatti* soil.

### KYATTI AND ITS CAUSE.

As a result of the examination of samples B84—B109 it was found that the majority of samples described as *kyatti* soils were strongly alkaline having pH $>$8·4 and frequently $>$9·75, although this was not quite without exception.

Determinations of certain chemical and physical data given in Table IV were carried out. There was no time to make proper estimations of the replaceable bases in each of the soils, and for convenience the whole of the carbonates was estimated and reckoned as replaceable bases merely by repeated extraction with dilute acid (M/20 HCl) and estimating the loss of acidity produced, the calcium in the filtrate being estimated. It was found that *kyatti* soils were generally highly calcareous, but, on the other hand, certain quite good soils were also highly calcareous, containing as much as 150 MEs of $CaCO_3$ and nearly 50 MEs of other bases.

Finally it was found that, by shaking the *kyatti* soils with either distilled or irrigation water (but not drainage water) in the ratio of one of soil to ten of water by weight, or one of soil to fifteen of water by volume, for a period of one hour, the *kyatti* soils were dispersed by the alkali they contained and gave relatively stable suspensions. A period of shaking for one hour only sufficed, after which average samples were quickly poured off into test tubes graduated at a depth of 4″, *i.e.*, the approximate depth to which clay should settle in eight hours. A slight variation of the test is obtained by adding phenolphthalein in neutralized concentrated alcohol to the tubes. In practice a volume of 1 per cent. phenolphthalein equal to half the volume of soil suspension was used. This settled overnight to about the same degree as the soil/water suspensions and, in addition, the alkalinity was clearly demonstrated by the pink or red colour developed, the intensity being roughly proportional to the amount of alkali present in the soil. From the results in Table IV it is clear that a good soil free from *kyatti* will give a depth of settled soil in the test tubes of less than ½″. and no colour or only very faint traces of pink will be developed by the phenolphthalein tubes. Between 0·5″ and 0·75″ depth of soil in the test tubes indicates soils which are potentially dangerous, the intensity of the pink colour developed deciding for or against them. If the depth of soil exceeds 0·75″, the soil is definitely a bad sample of *kyatti* and should be avoided if possible.

The two tests (*a*) with water only and (*b*) in presence of phenolphthalein solution are merely complementary and after practice in the field it is likely that only one need be used. The depths of soil setting to the bottom of the test tubes are roughly identical after a sufficient interval, *e.g.*, overnight, in spite of the increased viscosity of the alcohol-water solution compared with that of water.

In the tests quoted, the engineering opinion of the soils is given but it should be pointed out that soils B100—B104 have been judged by inspection only and have not been tested as yet by use for ordinary irrigation purposes. Actually the engineering opinion agrees absolutely with chemical tests on B100—B104.

Although in the cases of B79, B94, B97 (doubtful), B106, B108 and B109, the engineering opinion does not coincide with the results of tests recommended, it is considered more than likely that these soils are more easily wrongly described from the engineering point of view than from the chemist's point of view, simply because until engineering trouble has actually occurred and been noticed, the soil must be given the benefit of the doubt. It has already been explained that B79 is probably a good soil. B91 has been exposed to running water for five or six years and hence is presumably a satisfactory soil in spite of the adverse test. It is therefore possible that the sample obtained is not truly representative of the soil sampled or that the test is not adequate. The importance of accurate sampling can scarcely be overestimated, especially with the different results obtained with different horizons. The preliminary standards fixed for good, medium and bad soils may also require considerable modification in the light of further experience. For instance, the fact that B97 slips under rain may indicate that a limit of 0·5″ depth of soil in test tubes is excessive for a really good soil. It will further be noticed that several soils settle down to only about 0·25″. Further tests of soils B106, B108 and most particularly B109 which have not yet been exposed to running water will probably show only too clearly that these are unsafe to use.

A general phenomenon noticed is that even where good surface soil free from *kyatti* occurs in the dry zone, sampling to lower depths frequently indicates the presence of *kyatti* soil. This is noticed particularly on the Mandalay College farm where, below a depth of one foot, the presence of *kyatti* becomes more and more marked, being very marked indeed at 5′—6′ and down to 12′, the maximum depth sampled. It should be remembered that the presence of a zone of alkaline or neutral salts at a certain depth below the surface is to be expected in soils developed under conditions of medium or insufficient moisture conditions such as those in the dry zone of Burma. The presence of these alkaline or neutral salts in the absence of the protective action of organic matter (which is only adequate in the surface layers of soil) is enough to peptise the clay, giving a dispersed colloid. A perfectly good sample of soil free from *kyatti* may be very rapidly converted to bad *kyatti* by treatment with neutral salts such as KCl and more particularly NaCl. The fact that organic matter is lost under such conditions makes matters worse by removing the protective colloid (organic matter) which ordinarily prevents formation of *kyatti*.

It was not intended to publish any details of the field test described for

examining soils unfit to be used for bunding purposes until some experience had been gained in the hands of the Irrigation Department subordinate staff, but shortly after the method had been elaborated and successfully demonstrated, the publication of a series of papers on soil colloids by A. N. Puri [1930] appeared and some of these have a bearing on the same subject. The test described by Puri for soils rich in exchangeable sodium whereby a pellet of soil is worked up with water, dried and then dropped into water, soils rich in exchangeable sodium producing a turbid ring after a short interval, was arrived at quite independently, and this test was only discarded in favour of the one described because the latter was easier to follow on a more or less quantitative basis.

It will be realized that no ameliorative measures are proposed since in general it is better to alter the alignment of a canal than to attempt to rid the soil of alkali, a process involving considerable time, trouble and expense.

REFERENCE.

Puri (1930). *Mem. Dept. Agric. India Chem. Ser.* **11**,39-51.

## TABLE IV.

| Soil Laboratory No. | Locality and Public Works Department description | Per cent. $H_2O$-16 At sticky point (Colloidally held water) | Per cent. $CO_2$ in carbonate form | Tensile strength lbs. per ′. | MEs base extracted by M/20 HCl. | MEs of Ca as $CaCO_3$ | Replaceable bases other than Ca in MEs | pH | Proposed settling test and colour reactions with phenolphthalein solution (neutralized) |
|---|---|---|---|---|---|---|---|---|---|
| B79 | Myittha, R. D. 2500. Kyatti soil. | 16·44 | 0·30 | 3·86 | 54 0 | 13·6 | 40 2 | 8 05 | 0·5″ soil. Faint red colour only. Good soil. |
| B84 | Yamethin District, foundation of proposed dam; Thitson river Hteinmyetkon. Kyatti soil. | 9·9 | 0 27 | 0·90 | 34 0 | 12 2 | 21 8 | 8 1 | 0·8″ soil. Fairly strong red colour. |
| B85 | Kyaukse District. Ywakhaingyi. Ingon Road, 10′ depth. Sein-ni Kyat-si, i.e., greenish red Kyatti. | 18 19 | 1·005 | 1·68 | 59·0 | 45·7 | 13·3 | 9·0 | 1·0″ soil. Strong red colour. |
| B86 | As B 85, but at 15′ depth Kyat-si. | 13·11 | 0 40 | 1 38 | 27 0 | 18 2 | 8·8 | 9 4 | 1·3′ Ditto. |
| B87 | Exactly as B85 . . . . | 17·71 | 1·26 | 2·26 | 77 0 | 57·3 | 19·7 | 9·55 | 0 9′ Ditto. |
| B88 | As B86 . . . | 14·87 | 0 47 | 1·94 | 40·0 | 21·5 | 18·5 | 9 5 | 1·1″ Ditto. |
| B89 | Kanna Tank, bed of escape. Kyatti-pyu (i.e., white Kyatti). | 20 15 | 18 29 | 1·20 | 838·0 | 831·4 | 6·6 | >9·75 | 1·1″ Ditto. |
| B90 | As B89, but from side of escape. Kyatti-pyu. | 41·37 | 3·137 | 1·70 | 177·5 | 142·5 | 35·0 | 9·75 | 1·6′ Ditto. |
| B91 | Kun-ze canal, R. D. 26500, Depth 4′, Red Kyatti. | 11·34 | 3 70 | 2·97 | 189·0 | 168·3 | 20·7 | >9·75 | 1·1″ Ditto. |
| B92 | Taungdaw afflux, Bend of the Minye Weir, 4′ depth. Kyattisatpya (white alkali). | 12·42 | 3 92 | 2·00 | 192·0 | 177·9 | 14·1 | >9·75 | 1·0″ Ditto. |

TABLE IV—*contd.*

| Soil laboratory No. | Locality and Public Works Department description | Per cent. $H_2O$-16 At sticky point (Colloidally held water) | Per cent. $CO_2$ in carbonate form | Tensile strength lbs per | MEs base extracted by M/20 HCl | MEs of Ca as $CaCO_3$ | Replaceable bases other than Ca in MEs | pH | Proposed settling test and colour reactions with phenolphthalein solution (neutralized) |
|---|---|---|---|---|---|---|---|---|---|
| B93 | R D 7000. Kunze canal. below fall, good soil. | 22·46 | 3·43 | 0·385 | 180·0 | 155·7 | 24·3 | 8·05 | 0·4 soil. Colourless. |
| B94 | R. D. 37,000, from bed of Pyaungbya Canal, 6 depth, good soil. | 22·40 | 5·17 | 2·62 | 275·0 | 235·0 | 40·0 | >9·75 | 2·5″ soil Strong red colour. |
| B95 | R. D. 29,000, Right side of Sana Canal, 4 below ground level—good soil. | 16·64 | 3·92 | 0·57 | 200·0 | 178·2 | 21·8 | 8·05 | 0·3″ soil. Colourless. |
| B96 | R. D. 26,500, Kunze Canal. 4′ below bank soil, good loamy soil | 9·34 | 2·13 | 1·53 | 115·0 | 96·8 | 18·2 | 8·6 | 0·5 soil. Pink colour |
| B97 | Salin Canal Division Myaungmadaw canal at Imzin-Kyitmye. Slips under rain and tends to form a slurry in water. Considered a bad earth. | 18·37 | 0·12 | 0·78 | 20·0 | 5·3 | 14·7 | 8·15 | 0·45 soil. Faint pink colour |
| B98 | As B97 but from west side of canal Mye-ma Good sound soil. | 17·34 | 0·20 | 0·64 | 25·0 | 8·9 | 16·1 | 7·85 | 0·25″ soil. Colourless. |
| B99 | As for B97 and B98. West side of canal The-mye Good sound soil. | 11·21 | 0·38 | 0·63 | 40·0 | 17·2 | 22·8 | 7·85 | 0·25′ Ditto. |
| B100 | Salin R. D. 25 500. original alignment of Salin canal, Kyit-mye. Hills near by show bad ravining and hill wash. Considered unsuitable for building purposes | 19·98 | 0·53 | 1·52 | 50·0 | 24·0 | 26·0 | >9·75 | 1·3 soil Strong red colour. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| B101 | As for B100 but from R. D. 26,000 Kyit-mye. Soil considered to be identical with B. 100. | 30·10 | 1·34 | 2·23 | 56·0 | 60·7 | 25·3 | >9 75 | 1·3 Ditto, |
| B102 | Approved alternative alignment of Salin Canal R D 27,000 Mye-ma. This is soil from a valley near the hills of B100 and B101. Considered a good soil. | 14·20 | 0·88 | 1·41 | 68 0 | 39·9 | 28 1 | 8 15 | 0·3′ soil. Almost colourless |
| B103 | R. D. 28,500. Original alignment of Salin Canal. Kyit-mye. Considered so bad as to warrant diverting the canal | 12·05 | 1·87 | 0 91 | 116·0 | 54·9 | 31·1 | 8 50 | 1·0″ soil. Strong red colour |
| B104 | R. D. 28,500 As B103 but from a different horizon. Kyit-wa-the. | 9·62 | 0·44 | 0 57 | 46 0 | 20 2 | 25·8 | 8 2 | 0·9″ soil. Fair red colour. |
| B105 | R. D 36,000, Kyauk-mye-ni. Red earthy gravel. Has stood up well against weather action. | 5·81 | 3·13 | 0 63 | 190·0 | 142·3 | 47·7 | 7·85 | 0·25 soil. Practically colourless. |
| B106 | Toe of right bank of Paung Chaung at Salin Canal Crossing. R. D. 37 950, Mye-ma, a good earth which stands practically vertical for a long time. | 29 26 | 2·06 | 1 90 | 52·0 | 2·6 | 49·4 | 7 85 | 0·65′ soil. Faint pink colour. |
| B107 | R D. 38,000 on right bank of Paung Chaung at Salin Canal Crossing. The-mye-ni A good earth for cuttings and banks. | 8·71 | 0·04 | 0·53 | 18·0 | 1·8 | 16·2 | 6 6 | 0·20″ soil. Quite colourless. |
| B108 | R. D. 41,000. Near Sidoktaya Road Crossing. Kyit-mye. Has stood up well in banks. Rain action slight but not so good as B107. | 19·09 | 5·56 | 1·71 | 280·0 | 252·8 | 27·2 | 9·2 | 0 80″ soil. Strong red colour |
| B109 | R D. 41,000 as above but a different horizon. Kyit-kyauk-mye. | 19·35 | 3 09 | 1 36 | 174·0 | 140·4 | 33 6 | 9·25 | 1·3′ soil. Strong red colour. |

# COIMBATORE SEEDLING CANES.

## (Co. 281 and Co. 290 Described and Illustrated.)

BY

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### I. Introduction.

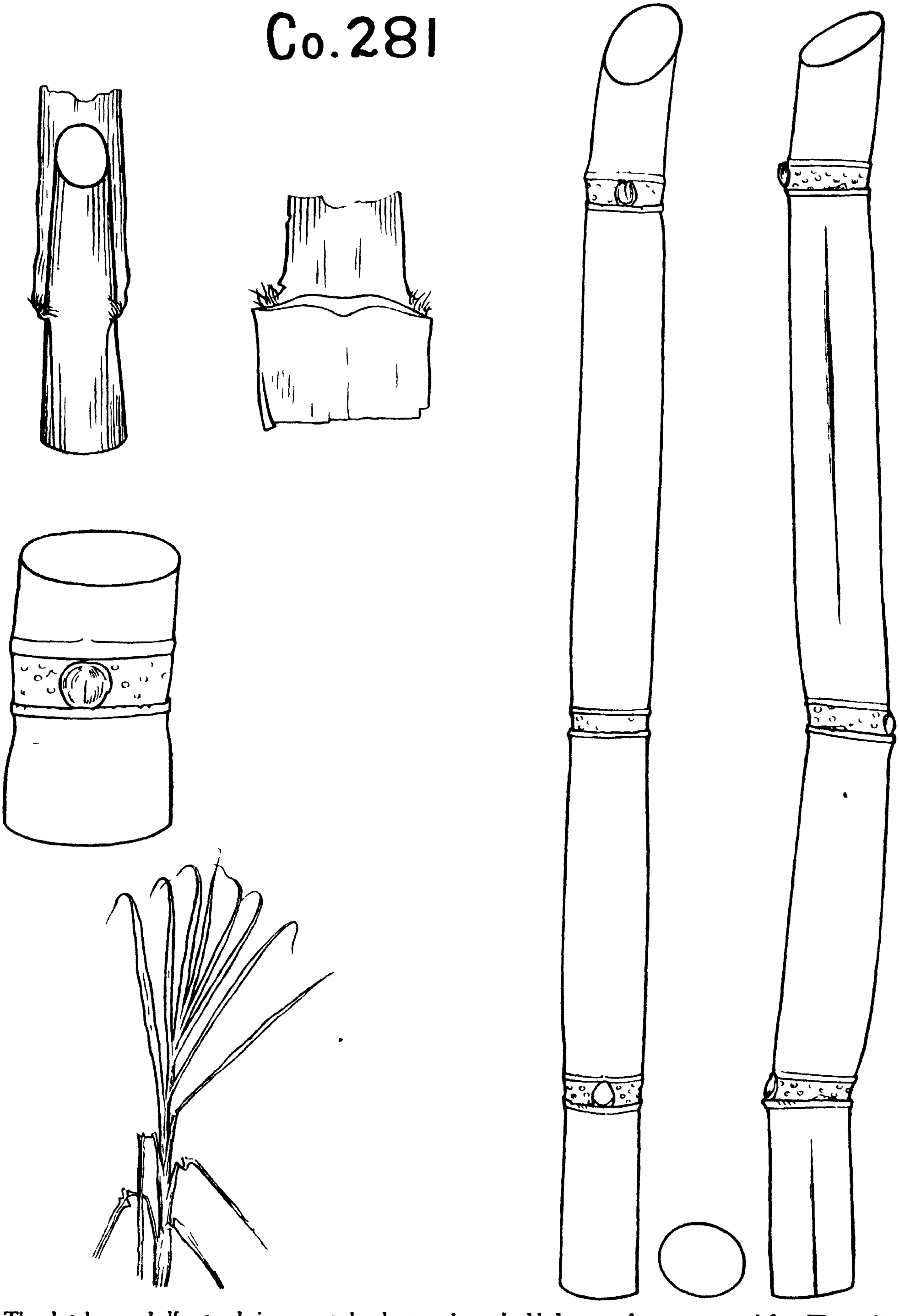
In the year 1928 [Venkatraman and Vittal Rao] brief illustrated descriptions were published of five of the popular Coimbatore seedlings, *viz.*, of Co.'s 205, 210, 213, 214 and 223. Since then certain of the later Coimbatore productions have been adopted in cultivation in India or elsewhere ; and two of these—Co. 281 and Co. 290—are described in this article. It is proposed to describe from time to time more of the Coimbatore canes as they are found useful and spread into cultivation. As before, the object of the present descriptions is mainly to help their identification in the field.

### II. Nature and scope of the descriptions.

The present descriptions have been drawn up on the same lines as the previous ones with what are considered certain improvements. Technical words have been kept at a minimum to render them useful to a wider class of readers. Though numerous and careful measurements have been recorded for many quantitative characters from various parts of India, these are not given here, as they vary from place to place and are therefore not of much use in field identification.

The coloured plates (Plates VII and IX) do not represent formalin-preserved material as in the previous case, but fresh canes painted on the spot and in the locality where the particular cane is at about its best. As is well known, the colour of a cane often varies according to the age of the crop and locality. Three pieces have been painted of each cane to try and cover such variations. A plate of line drawings (Plates VIII and X) has been included for each seedling to illustrate certain of the parts described ; and, where there is variation in a particular character, an attempt has been made to illustrate the extreme types.

PLATE VIII.




The sketches are half natural size except the shoot and one-budded cane piece at extreme left. The outline of the cane in cross section is represented at bottom between the two cane pieces at extreme right.

PLATE VIII.

Co 281.

PLATE VII.

## III. Characters Described.

The scheme of descriptions and characters employed is practically the same as before; and the reader is referred to the previous publication for a detailed account of the characters. A few minor characters have been added to the morphological descriptions and short notes included on the growth phases of the canes at different stages.

## IV. Co. 281 (Plates VII and VIII.)

(*a*) *Parentage*—

Cheribon × Chunnee → P. O. J. 213

Ashy Mauritius × Saccharum spontaneum → Co. 206

P. O. J. 213 × Co. 206 → Co. 281

*P. O. J. 213* ♀ × *Co. 206* ♂.—Unbagged cross. The mother arrow showed only one per cent. partially open anthers and there was little chance of unintended pollen reaching it. The seedling may therefore be assumed to be a hybrid between the parents indicated. The male parent, Co. 206, was one of the few markedly vigorous, distinctly narrow-leafed forms in a big lot of the usual broad-leafed seedlings of a cane of the 'noble' type called Ashy Mauritius in Madras and is assumed to be a natural cross with *Saccharum spontaneum.* This seedling possesses, therefore, the blood of *Saccharum officinarum* (from Cheribon and Ashy Mauritius), *Saccharum Barberi* (from Chunnee) and possibly of *Saccharum spontaneum* as well (from Co. 206).

(*b*) *Habit and general appearance*—

Habit erect. Often a neat mass of practically erect canes with the vinous or reddish vinous joints showing through the easily separating leaf-sheaths. The lamina soon separates itself from the sheath at junction except at the midrib and hangs down, giving a characteristic appearance in the field (Plate VIII). Deficiency of soil moisture is quickly indicated in this cane by an inrolling of the leaves. Foliage dark green, medium abundant.

(*c*) *Leaf*—

(1) *Lamina*—

(i) *Length and width.* Long; of medium width.

(ii) *Curvature.* Erect with a short sharp curve near tips.

(2) *Sheath*—

(i) *General.* Clasping canes loosely; marked tendency to self-strip. Often with a broad scarious border in adult leaves.

(ii) *Spines.* Absent.

(iii) *Ligular process.* Absent or scarious indication on one side.

(iv) *Ligule.* Of medium width, slightly depressed above and distinctly depressed below (sharply or broadly).

(*d*) *Cane*—

(1) *General.*—Fairly straight canes of medium thickness. Nodes practically even with joints. Cane as a whole slightly thinning or thickening upwards. Roundish in cross seetion. Solid.

(2) *Colour.*—(Young and adult canes.)—Vinous or reddish vinous with prominent fairly defined bloom bands and bright yellow root zones. (Old canes)—A distinct browning develops in older canes and in the older joints, the root zones turning concolourous.

(3) *Joint.*—Shape straight-sided. Groove absent. Ivory markings generally absent. Weather markings (Plate VII) fairly pronounced in certain localities and showing off prominently against the coloured joints. Splits present in moderate amount.

(4) *Bud*—

(i) *Size and shape.* Small to medium, just reaching growth ring or hardly so. Roundish or ovate. Rather flat.

(ii) *Flange.* Inconspicuous with prominent black hairs near apex. Bursting apical or sub-apical.

(*e*) *Germination and habit at different stages*—

Soon after germination the shoots are more or less erect, then become slightly oblique. At maturity, however, the canes form a neat mass of practically erect canes.

(*f*) *Sett and shoot roots*—

Total number of root eyes more than in Chunnee and less than in Hemja. Sett roots distinctly thicker than those of Hemja and as thick as those of Chunnee. At thirty days from planting, the sett roots are slightly shorter than those of Chunnee and twice as long as those of Hemja. Development of shoot roots later than in Chunnee or Hemja.

(*g*) *Adult root-system*—

The roots develop into almost an ideal system capable of tapping both the top and bottom layers of soil in 'red' or 'reddish' soils that are fairly open.

(*h*) *General remarks*—

A cane of medium thickness, excellent habit, very early in ripening and of high sucrose content. It has not yet been found of much use in India, but has attracted fair amount of attention elsewhere. It is found particularly adapted to 'red lands' and 'old exhausted soils' in Cuba and to the 'peat and muck' soils of Florida. It is proving more resistant to cold than any of the P. O. J. canes. It is very resistant to root diseases and practically immune to the leaf spot disease [Faris, 1928]. In Cuba it has shown itself susceptible but tolerant to mosaic; and at Pusa in India the Imperial Mycologist has found it 'resistant' to the disease [McRae and Subramaniam, 1928]. In a series of yearly observations carried on from 1925-26 to 1928-29 the Imperial Mycologist found the incidence of mosaic in this cane to vary from 0·1 to 3 per cent. [Pusa Agricultural Research Institute, 1930]. The experiences of the late Prof. F. S. Earle [1928] with this cane are extracted below :—

"This really remarkable cane seems to have attracted no attention in India, but in Cuba it is proving to be one of the richest in sucrose and earliest in maturity of all the many kinds under observation, being equalled in these respects only by the Badila, first one and then the other of these canes taking first place in all of the early-season analyses. It is usually late in March before even so rich a cane as BH 10(12) overtakes them.

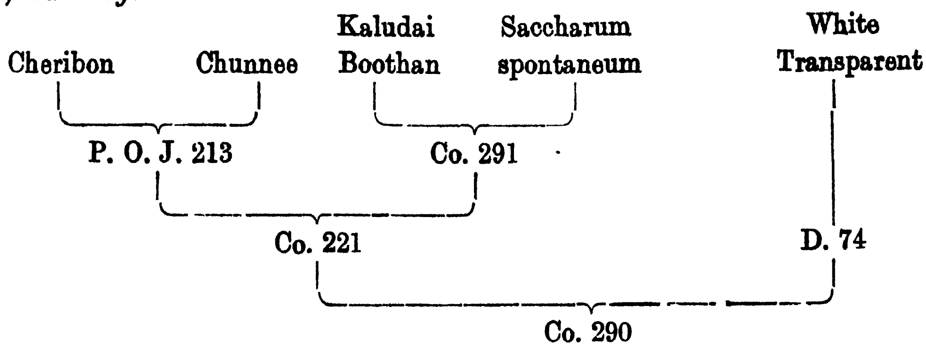
"It is being extensively planted, especially in the older red lands in Cuba where Crystalina begins to fail. It is perhaps hardly as resistant to extreme drought as Co. 213, but under any reasonable soil conditions it makes big tonnages and the juices are so rich, especially early in the season, that sugar-per-acre-yields promise to be very large. The trash sheds so freely and the cane is so clean that its comparatively slender diameter will not be especially objectionable in harvesting.

"It is susceptible to mosaic but seems to be fairly tolerant. It is very hardy and resistant to all root troubles.

"Its early maturity indicates that it may have very especial value for sub-tropical climates, where it is proving even more resistant to cold than any of the P.O.J. series."

## V. Co. 290 (Plates IX and X).

(*a*) *Parentage*—




*Co. 221* ♀ × *D. 74* ♂. Unbagged cross. Co. 221 has practically no fertile pollen of its own. The mother arrow was artificially dusted with pollen of D. 74, but there existed chances for pollen of the Indian indigenons cane Kansar reaching to the mother arrow. The male parent might, therefore, have been either D. 74 or Kansar. One of the grand parents, Co. 291, is a supposed cross between a 'noble' cane of Madras called Kaludai Boothan and *Saccharum spontaneum.* The seedling possesses therefore the blood of *Saccharum officinarum* (through Cheribon and Kaludai Boothan), of *Saccharum Barberi* (through Chunnee and perhaps Kansar), and possibly of *Saccharum spontaneum* as well (through Co. 291).

(*b*) *Habit and general appearance*—

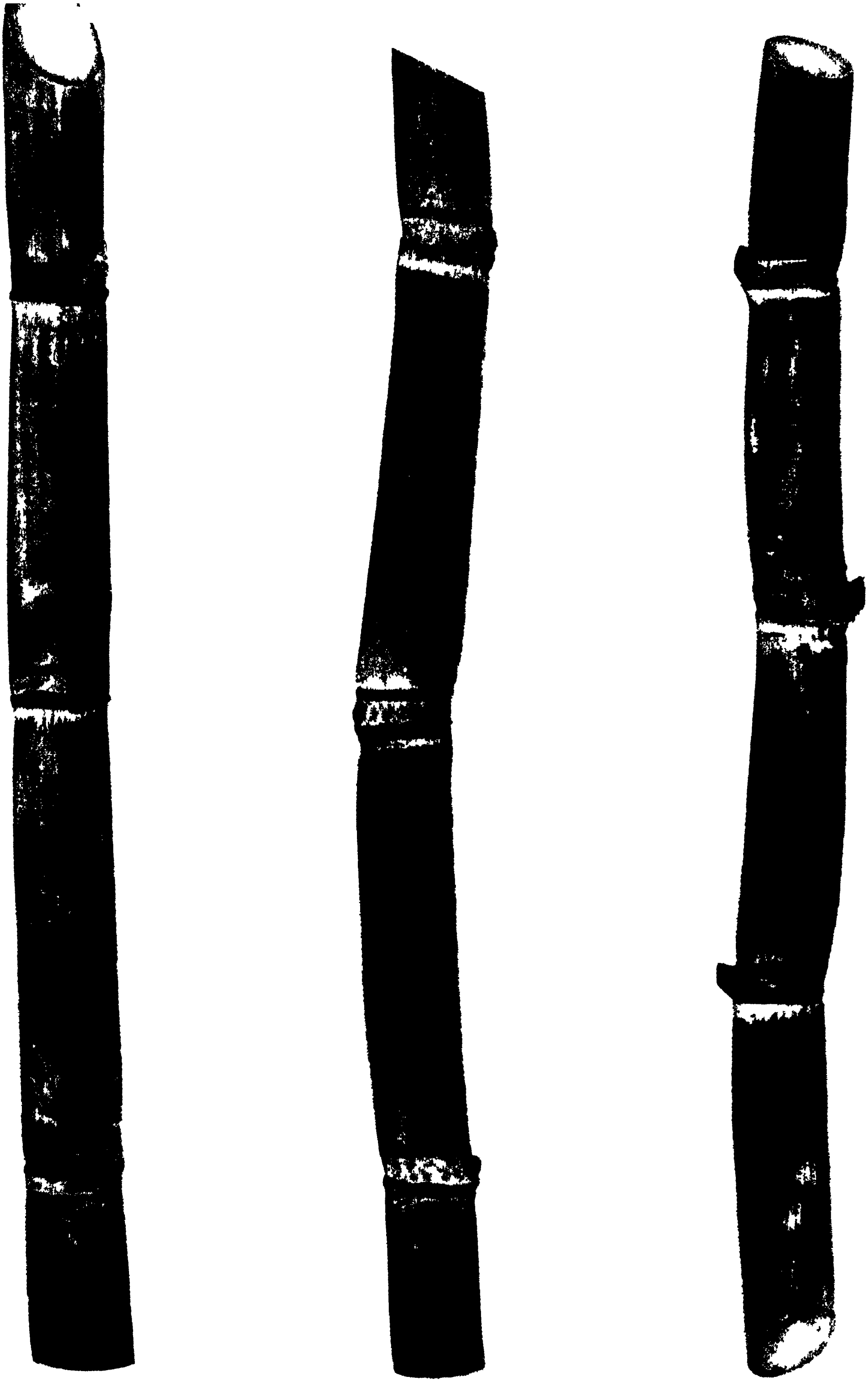
Habit erect or semi-erect. A rather loose mass of straight or slight curved canes with the joints showing through the splitting and separating leaf-sheaths. Foliage green, medium abundant. Certain of the leaves reverse themselves a little above half way (Plate X) resulting in a characteristic appearance of the general foliage, *viz.*, a mixture of the upper and lower leaf surfaces.

(*c*) *Leaf*—

(1) *Lamina*—

(i) *Length and width.* Long ; of medium width.

(ii) *Curvature.* (Young)—Broadly curved with a second sharper curve near tips ; (Old)—broadly curved.



# Co.290

The sketches are half natural size except the shoot and one-budded cane piece at extreme left. The outline of the cane in cross section is represented at bottom between the two cane pieces at extreme right.

(2) *Sheath*—

(i) *General.* Clasping canes loosely and easily detaching themselves. The older sheaths develop longitudinal splits often with purplish coloured margins.

(ii) *Spines.* Varying ; generally absent, sometimes present few, rarely in fair numbers.

(iii) *Ligular process.* Varying ; indicated or present on one or both sides, when present often scarious half inch long.

(iv) *Ligule.* Prominent ; arched above, broadly or sharply depressed below.

(*d*) *Cane*—

(1) *General.*—Fairly straight canes of medium thickness. Nodes practically even with joints. Roundish in cross section. Solid except for a narrow pithy central cavity in older joints.

(2) *Colour.*—Ground colour glaucous green with freequent blushes of purple or vinous purple ; older portions greenish brown. Fair quantities of bloom and occasional heavy blackening in certain localities.

(3) *Joint.*—Shape straight-sided, rarely slight thinning up. Groove practically absent. Ivory markings absent. Weather markings occasional or common. Splits absent, occasional or common.

(4) *Bud*—

(*i*) *Size and Shape.* Small to medium in immature canes. Sometimes swollen and brittle in mature specimens. Generally roundish, sometimes obovate. Fairly plump in mature canes. Bursting almost dorsal.

(*ii*) *Flange.* Conspicuous, rising about middle, broad at sides and often retuse at apex.

(*e*) *Germination and habit at different stages*—

The shoots are slightly oblique at germination, but erect themselves more or less about the fourth month. At maturity the clump forms into a rather loose mass of erect or slightly curved canes.

(*f*) *Sett and shoot roots*—

Total number of root eyes less than in Hemja but more than in Chunnee. Sett roots distinctly thicker than those of Hemja and at least as thick as those of Chunnee. At thirty days from planting they are slightly longer than those of Chunnee and four to five times as long as those

of Hemja. Development of shoot roots earlier than in Chunnee or Hemja.

(g) *Adult root-system*—

Though perhaps not quite as good as that of Co. 281 under the best of conditions for that cane, the root-system is satisfactory and develops strong, thick and deep roots under fairly satisfactory conditions of growth.

(h) *General remarks*—

A cane of medium thickness with heavy individual canes, early maturing and of satisfactory habit. In the United Provinces of India it has shown itself superior to the Coimbatore numbers preceding it in many respects. One defect reported from certain localities in India about this cane is its swollen and brittle buds standing out at maturity from the canes (Plate IX) and hence liable to injury unless carefully handled. At Pusa in India the Imperial Mycologist has found the cane 'highly resistant' to mosaic [McRae and Subramaniam, 1928]; in a series of yearly observations carried on from 1925-26 to 1928-29 the Imperial Mycologist found the incidence of mosaic in this cane to vary from 0 to 0·03 per cent [Pusa Agricultural Research Institute, 1930]. This experience has been largely confirmed from reports received from abroad. It was distributed abroad much later than Co. 281, but has been reported promising from more than one country. It is of a 'nobler' type than Co. 213 and, under satisfactory conditions of growth, is likely to do better than that cane. The Director of Agriculture [Clarke. 1927], United Provinces,* India, observes as below on this cane :—

"Co. 290 is in the opinion of the writer the best seedling cane yet produced at Coimbatore. It has been selected for wide distribution throughout the province and will materially assist in raising the standard of sugar production."

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* These provinces contain the largest area under sugarcane in India.

# RED GRAIN IN PADDY.

BY

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One of the commonest impurities in cultivators' paddy is red grain. Red being a simple dominant, the elimination of red grain is easy, the white-grained recessives breeding true at once. In the breeding area the detection of red grain presents no difficulty, but when the multiplication and distribution stage is reached and quantities running into hundreds of tons are concerned, the risk of red grain contamination becomes great and the detection of small amounts of red grain in the early stages an important matter calling for special attention. Such work forms part of the regular duties of district officers engaged in multiplication and distribution of pure lines, it being obvious that the term "pure line" necessarily becomes only relative after the seed has passed beyond the breeder's control for a few years. Of all impurities red grain is the most objectionable because of the increased milling it necessitates and the consequent higher breakage.

In order to make clear what is to follow a brief account of the method adopted in Burma for the production and multiplication of pure lines is given here. Selection is started with a small quantity, say half a pound, of cultivators' unselected seed, and the red grains are removed by hand-picking soaked seed before sowing. About 500 plants are grown and single plant selections are made. In the second year these are grown separately, some being discarded. In the third year single plant selections retained from the second year are yield-tested *inter se* and against the unselected. The three best are yield-tested again in the fourth year and in the fifth year one is multiplied up to about 800 lbs. This seed after rigid examination then leaves the breeder's hands for the first time and goes to the central farm concerned for further multiplication. If all the seed is utilized, some 15 acres will be planted and the produce, about 26,000 lbs., goes to tenants cultivating Government land or to Government seed farms in charge of junior

assistants. The third year in the hands of the district staff, that is the seventh from the initial selection, will probably see a crop of from 13,000 to 15,000 nine-gallon baskets of 50 lbs. each or about 300 tons. After the first year's multiplication on a central farm the quantity of seed to be examined for red grain becomes very large and, as will be shown later, requires special attention.

There are four methods of detecting red grain :—

1. If paddy grains are mounted in any of the common types of diaphanoscope, the red grains show up orange-red in colour compared with yellow for the white grains and so can be picked out. It is slow and laborious.

2. When paddy is soaked in water for 24 hours, the red grains can be distinguished easily, especially against a white background. This is the best method to adopt for small samples up to a pound or so. It is specially suitable for samples of unselected paddy brought in for selection. It is advisable to remove red grains at the beginning to prevent any possible crossing with valuable strains in the breeding area. If the soaking is started the day before the nursery is to be sown, a coolie can remove the red grains the next morning.

3. When it is not required to plant the seed actually examined it may be hulled with a roller and board (small samples) or in a hand huller such as the Burmese "cheik" (large samples).

4. In the field when the dew is on the plants red grain shows up clearly when viewed against the light and such plants can be rogued out. This becomes impracticable with large areas and ordinary planting. Its chief use is in the early stages.

It remains now to consider the procedure for detecting red grain when very large amounts of seed are concerned. The detection of red grain in most cultivators' samples, such as the mills handle, is simple. Usually one or more red grains can be found in a single sample of an ounce or about a handful which can be hulled with a roller and board. When selected seed is concerned, the amount of red grain present, if any, will be much less and its detection more difficult.

If a large number of equal-sized samples are examined and a frequency curve for numbers of red grain constructed, it will be found that when the average number of red grains per sample exceeds 15 the distribution will be practically normal. The examination of one such sample could be relied on with considerable confidence to reveal red grain if it were present, but if the sample were of the common size this would mean a very high degree of contaamination, far worse than any selected seed would ever contain. When the average number of red grains per sample falls below 15, the distribution curve for

red grain in a number of samples becomes increasingly asymmetric and no longer conforms to the Gaussian formula. Instead it accords with the Poisson distribution.

An actual case which occurred at Mandalay in 1929-30 is given to illustrate the kind of thing which may happen. A large quantity of paddy had been multiplied on the farm and was tested in the usual way by taking a few handfuls and hulling with a roller and board. It passed as free from red grain. In a separate experiment on milling quality larger samples of 7 lbs. were hulled and in a few of them red grains were found. A test was then done by taking a basket of paddy and passing it through a small hulling machine, dividing the hulled grain and chaff as it came through into 100 c.c. lots, that is, into samples of roughly one handful. These were then examined for red grain with the following result:—

| No. of red grains per sample | Number of samples observed | Calculated, Poisson distribution |
|---|---|---|
| 0 | 316 | 315·81 |
| 1 | 77 | 78·16 |
| 2 | 12 | 10·06 |
| 3 | .. | 0·89 |
| 4 | .. | 0·08 |
| Total . | 405 | 404·98 |

There is very close agreement between the numbers of samples observed and those given by the Poisson formula (interpolated from Pearson's Tables). In this case the average number of red grains per sample is 0·249, the total for the basket being 101. This means roughly 0·01 per cent. red grain.

Suppose there are 100 red grains per basket and it is divided into 400 samples, the average number of red grains per sample will be 0·25 and the number of samples which will be expected to contain no red grain will be given by $e^{-m}$ (where $m$ is the average number of red grains per sample), in this case 77·87 per cent., while 22·13 per cent. $(= 1-e^{-m})$ will contain one or more red grains. Hence the probability, $p$, that a sample will contain at least one red grain is 0·2213. If $q$ on the other hand is the probability that a sample will contain no red grain, then $q^n$ is the probability that none of the $n$ samples will contain a red grain and hence $1-q^n$ is the probability that a red grain will appear in at least one of the $n$ sam-

ples. Denoting this probability by $r$, we have $r=1-q^n=1-(1-p)^n$, since $q=1-p$.

If $r=1$, the probability of detecting at least one red grain becomes a certainty but for this the value of $n$ becomes infinite, so that the whole of the paddy to be examined must be hulled, which is obviously impracticable with large quantities. It is therefore necessary to fix some standard of certainty to which we must attain in our search for red grain. The usual value of 'P' adopted is 0·05, giving odds of 95 per cent. Engledow and Yule set $\frac{\bar{d}}{E_d}=3\cdot0$ as the standard for experiments involving field plots. This corresponds to P=0·003, giving odds of 997 to 3. If we take P=0·01 which gives odds of 99 to 1, we shall not be setting an unduly high standard.

Assuming, then, that we desire to detect red grain in 99 trials out of 100 when the amount present is 100 grains per 50 lbs. basket, that is, we desire to see at least one red grain, and if each of our samples is $\frac{1}{400}$ of a basket, we calculate the number of such samples that we must take thus ;

$$r=\frac{99}{100}=1-(1-0\cdot2213)^n,$$

$$(1-0\cdot2213)^n=1-\frac{99}{100},$$

$$=\frac{1}{100},$$

$$n\log(1-0\cdot2213)=\log\frac{1}{100},$$

$$=-2,$$

$$n=\frac{-2}{\log 0\cdot7787}=\frac{-2}{\bar{1}\cdot8914},$$

$$=\frac{-2}{-(1-0\cdot8914)}=\frac{2}{0\cdot1086},$$

$$=18\cdot42$$

The general formula for $n$ when the odds are 99 to 1 in favour of finding red grain is $n=\frac{2}{m\log e}$.

Taking the next highest whole number, so as not to reduce the odds in favour of finding red grain, we must take 19 samples if we wish to see at least one red grain,

the average number of red grains per sample being 0·25, the samples $\frac{1}{400}$ basket each and the odds 99 to 1 or slightly better. If we do not see a red grain in any of those samples, we may conclude within an error of one per cent. that the paddy does not contain more than 100 red grains per basket. It may contain less.

A hundred red grains per basket is rather a high degree of contamination for selected seed. Suppose there were 40 red grains per basket, then testing in the same way we should need to take 46 samples of $\frac{1}{400}$ basket each, thus :—

The average number of red grains is 0·1, so $e^{-m}=0{\cdot}9048$, so that 90·48 per cent. of the samples will be blank, giving a probability of 0·0952 for finding at least one red grain in a sample. Calculating as before we find that to be sure of finding at least one red grain in 99 per cent. of the trials we must take 46·05, say, 46 samples. Substituting in the general formula we have $n=\frac{2}{0{\cdot}1 \log 2{\cdot}7183}$, $n=46{\cdot}05$.

It is, of course, permissible to lump all the small samples together for purposes of examination. The size of the final sample to be hulled and examined for red grain will depend on the degree of accuracy desired and on the maximum amount of red grain considered permissible, since detection of very small amounts with absolute certainty is unattainable in practice. The following table has been drawn up to show the numbers of $\frac{1}{400}$ basket samples which would have to be examined for various degrees of red grain contamination, assuming that it is desired to detect red grain in 99 per cent. of the trials.

| Average number of red grains per sample | Minimum number of red grains per basket to be detected with odds in favour of 99 to 1 | $e^{-m}$ | Number of $\frac{1}{400}$ basket samples | Total weight of samples, lbs. |
|---|---|---|---|---|
| 0·0025 | 1 | 0·9974 | 1842 | 230·25 |
| 0·0125 | 5 | 0·9877 | 368·4 | 46·05 |
| 0·0250 | 10 | 0·9752 | 184·2 | 23·025 |
| 0·0500 | 20 | 0·9513 | 92·1 | 11·5125 |
| 0·1000 | 40 | 0·9048 | 46·05 | 5·756 |
| 0·1250 | 50 | 0·8824 | 36·84 | 4 605 |
| 0·2500 | 100 | 0·7787 | 18·42 | 2·3025 |
| 1·0000 | 400 | 0·3679 | 4·6 | 0·5756 |

So far a particular case using $\frac{1}{400}$ basket samples has been considered, but it is immaterial what sized samples are taken, provided that the paddy actually hulled and examined is a representative sample of the bulk. For example, if it is desired to detect red grain in 99 cases out of 100 when the amount present is one red grain in each 200 lbs. using one-pound samples, then

$$n=\frac{2}{0{\cdot}005\,(0{\cdot}4343)}$$

$$=\frac{2}{0{\cdot}0021715}$$

$$=921{\cdot}0 \text{ samples,}$$

and since each sample is one pound the total bulk which must be examined is 921·0 lbs. If samples of 5 lbs. each had been taken, then the end result would be the same,

$$n=\frac{2}{0{\cdot}025\,(0{\cdot}4343)}$$

$$=\frac{2}{0{\cdot}0108575}$$

$$=184{\cdot}2 \text{ samples,}$$

and since each sample is 5 lbs. the total bulk will be $5\times184{\cdot}2=921{\cdot}0$ lbs. If $n$ is fixed in units the actual bulk to be examined is calculated direct, as in the first example given above.

It is necessary to fix a limit above which red grain must be detected, if present, with the degree of certainty desired, here assumed to be 99 to 1. Different standards will be required according to the stage of multiplication reached. It is necessary that there shall be enough paddy drawn in small lots to make up the total necessary to give the desired degree of accuracy in the red grain test. If more than is necessary has been drawn, part can be discarded after careful mixing. If a high degree of accuracy is required, that is, small amounts of red grain are to be discovered, then in cases where the total bulk is small sufficient samples must be drawn to give a total quantity large enough to permit a red grain test of the required degree of certainty.

It is necessary that the samples taken shall be representative of the whole of the paddy to be examined. It is then permissible to bulk the small samples and to treat them as one for purposes of examination, provided that it is not desired to

know whether more impurity is present than the amount decided upon as the maximum permissible limit. When seed is in bulk as on a threshing floor a seed sampler must be used and samples taken from different parts of the heap, after making an estimate of the total bulk. Quantities less than 150 baskets will not ordinarily be examined by sampling and hulling methods but by examination of each plant in the field. It will be sufficient to take one sample for every second basket up to a total bulk of 300 baskets, and above that as follows :—

| | | | |
|---|---|---|---|
| For every | 3rd | basket when the bulk is from | 300 to 600 |
| ,, ,, | 5th | ,, ,, ,, ,, ,, ,, | 600 ,, 1,000 |
| ,, ,, | 10th | ,, ,, ,, ,, ,, | over 1,000. |

When seed is in bags samples must be drawn from the top, middle and bottom of every bag when the number of bags does not exceed 5, and for larger quantities as follows :—

| | | | |
|---|---|---|---|
| From every | 2nd | bag when the bulk amounts to from | 6 to 12 |
| ,, ,, | 4th | ,, ,, ,, ,, ,, ,, ,, | 12 to 36 |
| ,, ,, | 6th | ,, ,, ,, ,, ,, ,, ,, | 36 to 60 |
| ,, ,, | 10th | ,, ,, ,, ,, ,, ,, | over 60. |

It is for every officer to lay down for himself the degree of accuracy, certainty with which he desires red grain to be detected and the maximum permissible amounts, according to the circumstances. In breeding areas where not more than about half an acre of each strain is grown and where the spacing is wide, every single plant in the field can be examined and absolute certainty attained. It is otherwise in the later stages of multiplication.

The total number of grains per basket varies from about 800,000 to 1,250,000 according to the size of grain. It is often laid down in agreements with seed farmers and tenants of government land that their paddy seed shall be 99·5 per cent. pure, sometimes even less. Assuming there are one million grains per basket and that 0·5 per cent. of impurity is present all in the form of red grains, there would be 5,000 red grains per basket and 12·5 on the average in $\frac{1}{400}$ basket samples. The distribution would be nearly normal with only 0·0004 per cent. such samples devoid of red grain. But the degree of contamination would be impossibly high for selected seed.

It is considered that for paddy multiplied once on Government farms the maximum limit for red grain should be fixed at one per basket and for subsequent multiplications five per basket.

# ON THE EFFECT OF GINNING ON THE STAPLE-LENGTH OF COTTON FIBRES, AND ALSO ON THE RELIABILITY OF RANDOM SAMPLING.

BY

K. R. SEN, M.Sc.

## INTRODUCTION.

The present work was undertaken at the suggestion of Mr. G. R. Hilson, Cotton Specialist, Coimbatore, with a view to learn as much as possible with regard to the questions, *viz.*, whether the staple-length of cotton is greatly affected by ginning the *kapas* (seed-cotton) rather than separating the lint by hand, and also whether a random sample of *kapas* taken from the bulk of the produce and ginned yields a representative value for the average length of the fibres. The importance of the questions is, of course, obvious.

The cotton selected for the examination was a pure strain (**440**) of Cambodia (*G. hirsutum*). The *kapas* was secured from the produce of a self-fertilized, early sown, and duly irrigated plot of the year 1927-28.

## RANDOM SAMPLING.

At first a small quantity of *kapas* was taken from the produce of every line of the field, and made up into one sample. This sample was then ginned. Two Balls sorter and four Baer sorter tests were then made on it. The results are given in Table I below.

The difference of 0·02 inch in the values given by the two sorters is, of course, well within the limits of experimental error, as in the case of the Baer sorter a good deal of subjective error is introduced.

TABLE I.

*Results of the sorter tests on random samples.*

| Sorter | Average length (in.) 1st test | Average length (in.) 2nd test | Average length (in.) 3rd test | Average length (in.) 4th test | Mean average length (in.) |
|---|---|---|---|---|---|
| Balls . . . . | 0·91 | 0·91 | .. | .. | 0·91 |
| Baer . . . | 0·93 | 0·94 | 0·92 | 0·92 | 0·93 |

### PREPARATION OF SAMPLES.

Sampling was done by Balls' method [1921]. The whole bulk of *kapas* was divided into two apparently equal parts. Each of these two parts was next subdivided into two more; and each of the four parts thus obtained was divided again, and so on, until the whole produce was separated into 32 approximately equal parts. Out of each of these thirty-two divisions a sample of *kapas* was secured by a random selection of locks from all parts of it. In this way a total of 32 samples was obtained.

### PREPARATION OF SLIVERS.

All the locks in a sample were divided into six or eight equal parts (as the quantity permitted). From each of these parts one or two locks were selected at random. The lint from the locks thus selected, was separated from the seeds by hand and utilized to prepare a sliver from which one Balls sorter test was made. The results, in a concise form, are shown in column (*ii*) of Table II. After the completion of such tests for all the 32 samples the seed-cotton of the remaining locks of each sample was ginned separately in a hand-driven gin. The machine-separated lint of each sample was then tested for length by means of the Balls sorter. The results appear in column (*iii*) of the same table. The former method of lint-separation has been termed "hand-separated" in order to distinguish it from the latter method which has been referred to as "hand-ginned" or simply "ginned".

TABLE II.

*Results of sorter tests on hand-separated and ginned samples.*

| Average (*i*) Staple length (in.) | Hand-separated (*ii*) (Sample Nos.) | Ginned on hand-gin (*iii*) (Sample Nos.) |
|---|---|---|
| 0·88 | *Nil* | 21 |
| 0·89 | 2, 10, 12, 31 | 9, 13, 17, 19, 20, 28 |
| 0·90 | 4, 6, 9, 22, 26 | 5, 7, 10, 12, 14, 16, 26, 31, 32 |
| 0·91 | 15, 19, 28 | 1, 2, 3, 4, 6, 8, 15, 18, 24, 25, 29 |
| 0·92 | 1, 7, 13, 21, 32 | 11, 22, 23, 27, 30 |
| 0·93 | 3, 8, 20, 24 | *Nil* |

TABLE II—*contd.*

*Results of sorter tests on hand-separated and ginned samples*—contd.

| Average (*i*) Staple length (in.) | Hand-separated (*ii*) (Sample Nos ) | Ginned on hand-gin (*iii*) (Sample Nos.) |
|---|---|---|
| 0·94 | 5, 11, 17, 25 | *Nil* |
| 0·95 | 16, 18, 29 | *Nil* |
| 0·96 | 23, 27, 30 | *Nil* |
| 0·97 | *Nil* | *Nil* |
| 0·98 | *Nil* | *Nil* |
| 0·99 | 14 | *Nil* |
| Mean average length . . | 0·92 inch | 0·90 inch. |

### DISCUSSION OF THE AVERAGES.

A probable error of 1·9 per cent. (single observation) for the results in column (*ii*) indicates a fair degree of uniformity in spite of the possibility of variations within a sample consisting of locks selected at random. The probable error (single observation) for hand-ginned samples, however, is about 0·9 per cent. which is within the limits of experimental error.

### COMPARISON OF THE TWO SERIES OF RESULTS.

It is clear, however, that although the average values for the individual tests in column (*ii*) of Table II vary greatly amongst themselves yet the mean given by all the samples together does not differ, beyond the limits of error, from that given by the ginned samples. If we consider at the same time the uniformity of the values yielded by the ginned samples, we can say that the average length of a cotton as obtained from a *random ginned* sample is a fairly representative one. The effect of ginning appears merely to make the distribution of the fibres homogeneous by inter-mixture. A comparative study of the individual values of columns (*ii*) and (*iii*), Table II, indicates that the average staple-length of ginned cotton is slightly less than that of hand-separated cotton.

It appears from Table III, which gives the percentages of distribution for different lengths in the case of three typical samples, that ginning causes the breakage of a certain percentage of long fibres (at least an inch) and that these broken fibres increase the percentages of the short fibres, *i.e.*, those between ¼ inch and ⅞ inch. In the following table "S" stands for "hand-separated" and "G" for "ginned on hand-gin".

TABLE III.

*Effect of ginning on the distribution of fibres for three typical samples.*

| Mean length of sections (unit ⅛ in.) | Sample No. 5 | | Sample No. 14 | | Sample No. 30 | |
|---|---|---|---|---|---|---|
| | "S" | "G" | "S" | "G" | "S" | "G" |
| 2 | 0·9 | 1·3 | 0·7 | 1·5 | 0·8 | 1·0 |
| 3 | 1·2 | 1·9 | 0·9 | 1·9 | 1·0 | 1·5 |
| 4 | 2·4 | 3·8 | 1·6 | 3·3 | 1·7 | 2·3 |
| 5 | 4·5 | 7·0 | 3·7 | 7·4 | 5·7 | 6 7 |
| 6 | 8·1 | 11·6 | 6·8 | 12·0 | 6·5 | 11·2 |
| 7 | 22·8 | 24·8 | 14·7 | 23·2 | 16·4 | 23·1 |
| 8 | 37·3 | 31·6 | 33·9 | 30·0 | 36·3 | 33·1 |
| 9 | 22·3 | 18·0 | 30·2 | 20·7 | 31 6 | 21·1 |
| 10 | .. | .. | 7·5 | .. | .. | .. |

It is quite clear from the above that for fibres of length between ¼ inch and ⅞ inch the percentage of distribution corresponding to a particular mean length is greater for the ginned sample than for the hand-separated one, whereas for longer fibres the reverse is the case.

TABLE IV.

| Mean length of sections (inch) | Method of lint-separation giving the predominant percentage | Actual percentage of the total No. of samples showing clear predominance (round nos.) |
|---|---|---|
| ¼ | G | 88 |
| ⅜ | G | 94 |
| ½ | G | 84 |
| ⅝ | G | 84 |
| ¾ | G | 78 |
| ⅞ | G | 59 |
| 1 | S | 91 |
| 1⅛ | S? | 50 |
| 1¼ | S* | 100 |

* Wherever 1¼ inch section occurs.

Table IV above gives in round numbers the percentage, out of the total number of samples of cotton tested, for which the foregoing rule holds. The few exceptions appear to be due to one or more of the following causes:—

1. Ginning seemingly destroys most of the fibres of about 1¼ inches in length as such, and thereby increases the percentages of the immediately shorter sections.

2. Hand-separating mostly breaks fibres of not less than 1⅛ inches length which in certain samples exist in a considerable number (probably owing to an unconscious selection of good locks).

3. In hand-separation the seeds retain more of the smaller parts of the broken fibres than they do on ginning, in which case the parts of the fibres that stick to the seed are generally very small (say, less than a quarter of an inch).

Simple mathematics enables us to determine the probable number of parts into which ginning breaks certain fibres relatively to the process of hand-separation. The following treatment shows how the actual number of such damaged fibres in a given quantity of cotton can be calculated.

Let "N" denote the total number of fibres in any section of mean length "l" in a Balls sorter pattern, the sample having passed through a process of hand-separating "S". Let "n" denote the number of fibres by which this section changes (relatively to the process "S") when the same sample is passed through the process of ginning "G". Let "$P_S$" be the percentage of fibres in the above section given by $\frac{100\ w_S}{W_S}$. Where "$w_S$" is the weight of this section, "l" and "$W_S$" is the total weight of all the Balls sorter sections after the process "S". Let "$P_G$" similarly denote the percentage given by $\frac{100\ w_G}{W_G}$ after the process

"G". Let "f" denote the fibre-weight of the cotton per unit length assumed to be the same for all lengths of fibre.

Then the total number of fibres in the section "l" after alteration by the process "G" is given by

$$N+n$$

So the weight of the section, or $w_G = (N+n)\,f.\,l.$

$$\therefore\ P_G = \frac{100\,(N+n)\,f.\,l.}{W_G} \quad \text{or} \quad N+n = \frac{P_G \cdot W_G}{100\,f.\,l.} \qquad \ldots\ldots\ldots\ldots (1)$$

$$\text{Similarly, } N = \frac{P_S.\,W_S}{100\,f.\,l.} \qquad \ldots\ldots\ldots\ldots (2)$$

From (1) and (2) by eliminating "N" we have

$$n = \frac{1}{100\,f.\,l.}\,(P_G \cdot W_G - P_S.\,W_S)$$

Now putting $W_S = W_G = 100$ units (say), we have the actual change in the number of fibres given by

$$n = \frac{1}{f.\,l.}\,(P_G - P_S).$$

TABLE V.*

*Value showing the changes in the No. of fibres on ginning for different sections.*

| Mean length of sections (inch) | "n" for the sample numbers | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | 8 | 14 | 16 | 18 | 23 | 27 | 30 |
| $\frac{1}{4}$ | +360 | +450 | +720 | +540 | +270 | +180 | −90† | +180 |
| $\frac{3}{8}$ | +420 | +120 | +600 | +360 | +120 | +240 | +120 | +300 |
| $\frac{1}{2}$ | +630 | +225 | +765 | +315 | +315 | +225 | +405 | +270 |
| $\frac{5}{8}$ | +900 | +720 | +1,332 | +972 | +468 | +612 | +864 | +360 |
| $\frac{3}{4}$ | +1,050 | +1,050 | +1,560 | +1,200 | +450 | +1,290 | +1,140 | +1,410 |
| $\frac{7}{8}$ | +514 | +1,208 | +2,186 | +977 | +1,311 | +874 | +591 | +1,723 |
| 1 | −1,395 | −1,733 | −878 | −1,463 | −225 | −1,260 | −1,193 | −721 |
| $1\frac{1}{8}$ | −860 | −420 | −1,900 | −620 | −420 | −240 | −840 | −2,100 |

In the above table we have such actual numbers calculated on the assumption that the fibre-weight of the cotton is of the same order, *viz.*, $1{\cdot}75 \times 10^{-6}$ grm. per

* The weight of cotton for which the figures in this table have been calculated is 100 mg. In the table "+" indicates an increase and "—" a decrease in the number of fibres by the specified amount.

† The occurrence of this negative value cannot be explained properly. It may be due to a comparatively greater loss of fibres of this length during one of the processes.

cm. [Turner, 1928] as that of CO. 1 (Cambodia 295) which is another pure strain evolved out of the same stock.

In the case of sample Nos. 5, 8, 27, 30, the sections with regular distribution of fibres extend up to 1⅛ inches only in both hand-separated and hand-ginned samples. In the case of sample Nos. 14, 16, 18, 23 the sections with regular distribution extend up to 1¼ inches (in each case) for the hand separated samples and up to 1⅛ inches only for the ginned ones. These facts indicate that, in the latter case, there is a considerable number of fibres 1¼ inches long within each sample even after hand-separating which would be broken during ginning and so would increase the percentages of the lower sections thus diminishing the amount by which the number of fibres decreases in the sections of length 1 inch and 1⅛ inches respectively, and also exaggerating the amount by which the number of fibres increases in any of the other sections. Such a phenomenon will obviously lead to the fact—

2 (total decrease) $<$ (total increase)............ Class II

in the above table, whereas in the other (more normal) case (assuming throughout that the breakage of each long fibre gives only two short fibres, some of which are exceedingly short, *i.e.*, $<$ ¼ inch)—

2 (total decrease) $>$ (total increase)........ Class I.

That these conclusions agree remarkably well with the results of the experiments, is shown in the following table (VI).

TABLE VI.

(*a*) *Class I.*

| | Sample No. 5 | Sample No. 8 | Sample No. 27 | Sample No. 30 |
|---|---|---|---|---|
| Total increase between sections ¼ inch and ⅞ inch. | + 3,874 | + 3,773 | + 3,120 | + 4,243 |
| 2 (total decrease) for 1 inch and 1⅛ inches sections. | − 4,510 | − 4,306 | − 4,246 | − 5,642 |

(*b*) *Class II.*

| | Sample No. 14 | Sample No 16 | Sample No 18 | Sample No. 23 |
|---|---|---|---|---|
| Total increase between sections ¼ inch and ⅞ inch. | + 7,163 | + 4,364 | + 2,934 | + 3,421 |
| 2 (total decrease) for sections 1 inch and 1⅛ inches | − 5,556 | − 4,166 | − 1,290 | − 3,000 |

One point of interest is furnished by sample No. 14. The abnormal figure (Table V) for the breakage of $1\frac{1}{8}$ inches fibres indicates the existence of a comparatively large percentage of such fibres in the hand-separated sample leading to such a high value for the average staple-length (Table II).

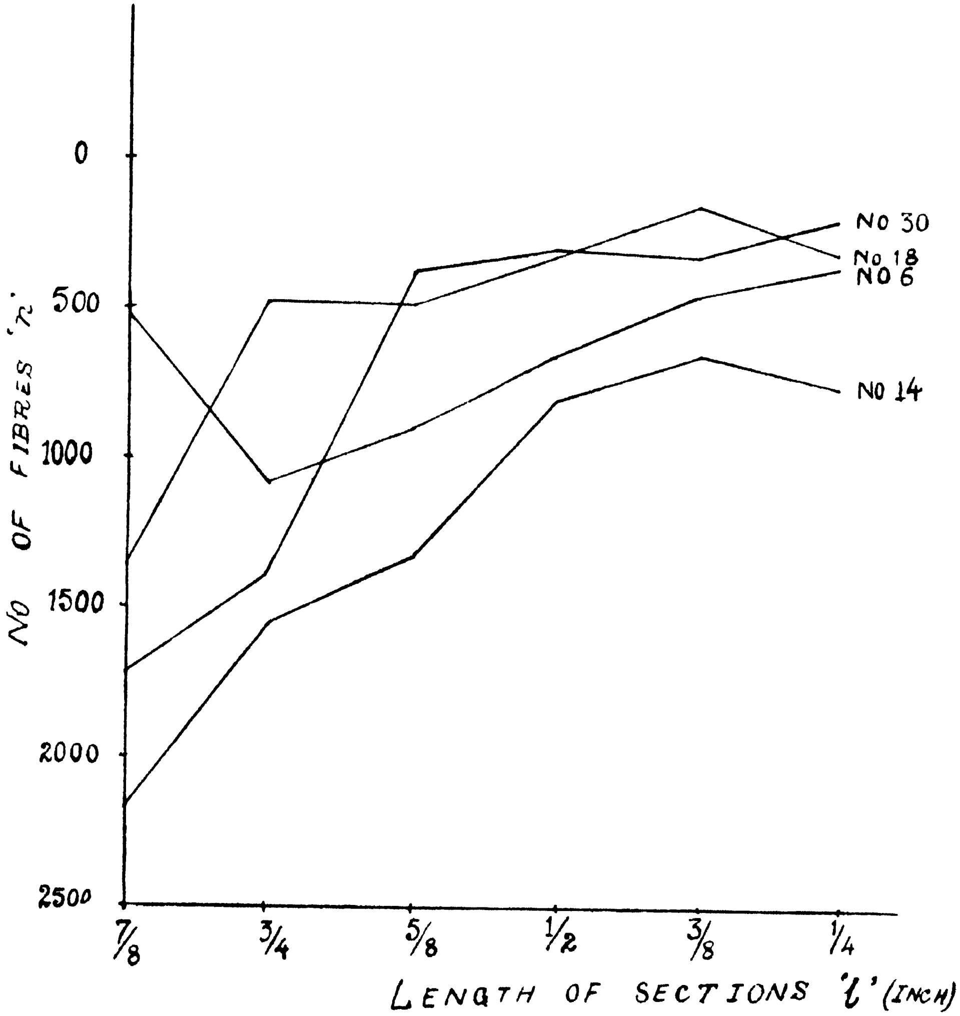


Fig. 1

Figure 1 is the curve of distribution of the broken parts of the fibres after ginning relatively to hand-separation. In certain cases there is a distinct stoop at the top end of the curve which indicates an exaggerated gain of very short fibres.

## CONCLUSIONS.

The conclusions from the experiments may be summed up as follows:—

(*i*) random selection of a sample from a bulk of cotton, provided the bulk has been ginned and thereby inter-mixed, is sufficient to represent the bulk so far as the average length is concerned ;

(*ii*) ginning produces some breakage among fibres of length about 1 inch and above, thereby decreasing the percentages of fibres above an inch in length and at the same time increasing those of shorter lengths ;

(*iii*) there is a possibility of a considerable number of fibres over one inch in length breaking during hand-separating.

(*iv*) the effect of ginning on the average length for an individual sample is not very remarkable, being so slight as to be within the limits of experimental error.

This work can be extended further by observations on cottons shorter or longer than the type used. In the present case the mode lies near about an inch, *viz.*, 1·02 inches (estimated on the plush).

## ACKNOWLEDGMENTS.

The author wishes to express his thanks to Mr. R. C. Broadfoot for his kind interest in this paper. He also desires to acknowledge his indebtedness to Dr A. James Turner for his valuable help and suggestions.

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COIMBATORE ;
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# EXPERIMENTS ON DISINTEGRATION OF BONES FOR USE AS FERTILIZERS.

BY

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The question of conserving the phosphoric acid supply of soils has been engaging the attention of those interested in the cause of Indian agriculture. The export of bones, oil-seeds and grains entails a loss of this constituent, and where suitable returns are not made to the land, the recuperative processes going on in the soil of certain localities do not suffice to keep up a supply of available phosphoric acid adequate for vigorous growth of plants. It is therefore very desirable that means should be devised to utilize within the country the large amount of bones which is now exported to the foreign parts. The difficulties in this connection are mainly two in number. In the first place most of the cultivators have strong prejudices against the use of bones. It is expected, however, that when convenient methods of treating bones are devised and their effectiveness in increasing crop yields is clearly demonstrated they would come into general use. The second difficulty consists in their refractory nature. While powdered bone is a good fertilizer, the effect of bones in big pieces is very slow. But the cultivators find it well nigh impossible to crush bones with the means at their command.

This subject was discussed at the first meeting of the Fertilizers Committee appointed by the Imperial Council of Agricultural Research held at Simla in June 1930, when the representatives from the Pusa Institute undertook to carry out experiments to find out easy methods of disintegrating bones. The investigation is not yet completed, but it is thought that a short account of the work done up to this time may prove to be of interest. Five methods of procedure suggested themselves—(1) subjection to superheated steam, (2) treatment with solutions of easily available chemical reagents, (3) fermentation in composts, (4) calcination, and (5) extraction with solvents which would leave the residue in a friable

condition. Experiments on processes (1), (2) and (3) have been conducted and an account of the results is being given later. Method (4) appears to be a fairly simple process which can be availed of by villagers. But as burning bones within the Estate would constitute a great nuisance, no such experiments were attempted at Pusa. As to (5), although it presents certain advantages, it was thought difficult to fit it in with the existing industrial conditions in the country.

A consideration of the results obtained under methods (1), (2) and (3) will now be taken up. With reference to the analytical data quoted in these connections a few words may be said about the composition of bones. The mineral portion of bones consists mainly of tricalcic phosphate, along with other salts. Interlacing the complete mineral framework is the cartilage, composed of nitrogenous compounds, with which are associated fatty substances. The amounts of these constituents vary with the nature of the animal, its age and development, and the anatomical part of the body from where the particular bone is derived. The composition also varies with the previous history of storage. It thus follows that to get a really representative sample of a consignment of bones is very difficult, and that it is permissible only to make rough generalisation from the figures recorded.

### I. Treatment with superheated steam.

That bones can be rendered more brittle by subjecting them to the action of steam under pressure has already been known, and in many bone treatment establishments this procedure is had recourse to. In the present study preliminary experiments demonstrated that autoclaving pieces, broken up to 3 to 4 inches length, for two hours at 130°C. yielded very good products. Big bones about 18″ long had to be maintained at 130°–135°C. for three to four hours. When the temperatures were maintained lower than 130°C. a longer period was necessary, *e.g.*, at 120°C. it was necessary to heat the bones for six hours or more. In these experiments the bones were rendered friable enough to be powdered with gentle pressure. Where the object is to render them only sufficiently brittle to be capable of being broken up with the help of a country *dhenki*, two hours' heating at 130° C. should do.

During the process of heating volatile products escaped with the steam and some material dissolved in the water. In the solid residue there is a loss of nitrogen but the phosphoric acid is conserved. Analysis of a sample of raw bones showed that there was about 4·5 per cent. nitrogen and 24 per cent. phosphoric acid (calculated on a dry basis). The steamed bone was found in one experiment to contain 1·8 per cent. nitrogen and 26 per cent. phosphoric acid. After the treatment

there remained in the aqueous liquid 1·52 grm. nitrogen and 0·008 grm. phosphoric acid for every 100 grm. raw bones taken. Some of the results are given below.

TABLE I.

*Composition of steamed bones ( calculated on dry basis).*

| Raw bone | | Organic nitrogen | Phosphoric acid |
|---|---|---|---|
| *Raw bone* | | *4.59* | *24·23* |
| Experiment | 1 | 2·13 | 23·72 |
| „ | 2 | 1·74 | 24·62 |
| „ | 3 | 1·96 | 26·10 |
| „ | 4 | 1·56 | 25·98 |

It would be of importance to compare the fertilizing power of the steamed bones with that of raw bones by conducting field trials. Figures obtained by the usual ammonium citrate method of determination are recorded here. Steamed bones obtained in the present investigation were tested along with a commercial sample of bonemeal received from Calcutta. As the solubility was expected to vary with the fineness of the material, the meal had been divided into different grades of fineness with the help of sieves.

TABLE II.

*Grm. of $P_2O_5$ dissolved in ammonium citrate from 100 grm. of $P_2O_5$ present in the bones.*

| Raw bonemeal | | | Steamed bone |
|---|---|---|---|
| Particles above 1·5 mm. | Particles between 1·5 and 1 mm. | Particles below 1 mm. | Particles below 1 mm. |
| 1·95 | 31·18 | 42·46 | 77·56 |

The figures recorded above are not strictly comparable, as the raw meal was of a different origin from the steamed product. Moreover it may be that the bigger particles of meal, which were separated by 1·5 mm. sieve, were not only harder than the rest of the fractions and thus escaped disintegration, but were at the same time chemically more refractory than the residual part which passed through the 1·5 mm. sieve. It is known for example that the outer "vitreous" parts of bones are much tougher than the "spongy" material in the inside. And

in the course of experiments, to be referred to later, it was observed that the former are more resistant to the action of chemical reagents like caustic alkalis.

But even acknowledging the above limitations, the wide difference in the solubility figures demonstrates that steamed bonemeal is a much more valuable fertilizer than raw bones. This is quite in accordance with the generally accepted view.

The autoclave used in the above experiments was a small laboratory apparatus heated with gas. To work the process in an economic way, less expensive heating arrangements would have to be put up and cheaper and bigger contrivances would be necessary.

II. Treatment with chemicals.

The action of solutions of various mineral salts on bones at ordinary temperatures and in the heat was first studied. Not much action was noticed. Signs of yielding were observed only with alkali carbonates. Solutions of caustic alkalis gave much better results, and addition of sodium chloride seemed further to favour the reaction. Trials were therefore conducted with solutions of various strengths of carbonates and hydroxides of sodium and potassium with and without the addition of sodium chloride. The higher the strength of caustic alkali, the quicker was the reaction to occur, but there was a limit of period of activity after which the reaction proceeded at a very slow rate; this period varied with the strength of alkali, being shorter in the case of stronger solutions. In the case of caustic soda solutions of strength below 1·5 per cent. and with caustic potash solutions below 2 per cent. in strength, the disintegration seemed to be negligible. The presence of sodium chloride was of help in accelerating the action. The prevailing atmospheric temperature is also of significance.

Some experiments were next performed to find out the effect of different concentrations of salt used in conjunction with the alkali for which the data are noted below.

Table III.

*Effect of alkalis on bones.*

(Atmospheric temperature 75°—90° F.)

| Treatment | Duration of treatment | Days after which the reaction slackened | Grm. Bone. | | |
|---|---|---|---|---|---|
| | | | Taken | Disintegrated | Not disintegrated |
| 1·5 % NaOH, alone | 89 days | 40 | 1,000 | 518 | 482 |
| " + 1 % NaCl | 69 " | 30 | 1,000 | 736 | 264 |
| " + 2 % NaCl | 69 " | 30 | 1,000 | 723 | 277 |

Keeping the bones in 1·5 per cent. caustic alkali for three months disintegrated only half of them, while in the case where 1 per cent. common salt was used in addition three-fourths of the bones were broken up during the course of two months. The bulk of the reaction, however, took place really within 40 and 30 days respectively.

It may be mentioned here that when bones suffer disintegration through the action of alkalis it is the less resistant portions which are the first to yield, the action gradually proceeding to the more resistant fractions, but there are portions (*e.g.*, some of the shafts and joints and specially the teeth) which are very refractory. As a result a fraction of the bones escapes disintegration.

In these experiments bones were taken to be "disintegrated" when it was possible to break them up to coarse powder with gentle pressure in a porcelain mortar. The residual pieces of bones (which, as noted, amounted to about a quarter of their original weight) were after the treatment left in a loosened and peculiarly laminated condition. Much of these latter could be broken off by hand in the rm of flakes. Vigorous pounding could also serve to crush them.

Chemical analyses showed that disintegration through the agency of alkali was associated with leaching out of organic matter. The product was poorer in nitrogen and richer in phosphoric acid, as will be seen from the following table.

# TABLE IV.

*Change of composition effected by alkali treatment.*

(Temperature 75° — 90° F.)

| | Days of treatment | Composition of solid residue (grm. in 100 grm dry matter) | | | | | | Final composition of liquid (grm. in 100 c c.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Phosphoric acid ($P_2O_5$) | Corresponding tri-calcic phosphate ($Ca_3P_2O_8$) | Organic nitrogen | Organic matter | Insoluble silicates and sand | Carbonic acid ($CO_2$) | Total alkali calc as $\frac{Na}{K}$ OH | Free alkali $\frac{Na}{K}$ OH | Fixed alkali $Na_2CO_3$ $K_2$ | Phosphoric acid $P_2O_5$ | Organic nitrogen |
| *Raw bones* | | 27·27 | 59·53 | 4 45 | 30 57 | 2 40 | 2·37 | | | | | |
| 2·5 % NaOH , alone . | 92 | 29·22 | 63·80 | 2·26 | 18·23 | 0 19 | 4·57 | 1 35 | 0·58 | 1·06 | 0·0060 | 0 74 |
| 2% NaOH , ,, . | 44 | 31 04 | 69 08 | 2 60 | 20 15 | 0 30 | 4·59 | ... | 0·65 | ... | 0·0058 | 0 51 |
| 1·5 % NaOH , ,, . | 89 | 28·44 | 62·09 | 2 65 | 20·47 | 1 12 | 4·78 | 0·84 | 0 29 | 0 73 | 0·0030 | 0·41 |
| 1·5 % NaOH +1·0 % NaCl | 69 | 28·55 | 62·33 | 2·69 | 21 80 | 0 89 | 4 70 | 0 78 | 0·35 | 0·57 | 0·0043 | 0·42 |
| 1·5 % NaOH +2·0 % NaCl | 69 | 26·27 | 57·34 | 2·90 | 21 84 | 0 76 | 4 54 | 0·73 | 0·35 | 0 50 | 0·0031 | 0·43 |
| 2·5 % KOH +1·0 % NaCl | 34 | 31·01 | 67·71 | 3·04 | 24·11 | Traces | 4·29 | | 0·67 | | 0·0076 | 0 38 |
| 2 % KOH + 1·0 % NaCl | 45 | 27·71 | 60 49 | 3 06 | 24 94 | 1·33 | 4·49 | ... | 0 44 | ... | 0·0055 | 0·22 |

The study is being continued.*

The experiments so far done had been all conducted on a small scale and in glass vessels. Larger amounts are being taken and vessels such as would be capable of being used by cultivators are being investigated.

### III. Fermentation in Composts.

It is known that when bone-meal is placed in heaps with suitable composting materials and appropriate conditions for fermentation are maintained, it enters into putrefaction and becomes a much more energetic manure than ordinary bonemeal. Attempts are being made to find out whether such fermentative processes are also effective in loosening the mechanical structure of pieces of bones. It has been thought worthwhile to find out what happens under broadly differing types of bio-chemical activities. With this end in view, various concomitant fermentative materials have been mixed with the bones, *e.g.*, cattledung, urine, molasses, waste curds. etc. To give body to the composts, additions of soil, sand and charcoal have also been made. Care is being taken to maintain the requisite moisture content by adding water when necessary to make up the loss by evaporation. Periodical examinations are being made of the composts to see how the bones are behaving. It is not yet possible to definitely state anything except that bones kept in the compost containing sand, charcoal, dung and molasses are showing some signs of yielding.

### IV. Summary.

In view of the vital importance of phosphates in promoting growth and development of crops, it is highly desirable to increase the available supply of phosphatic manures to the cultivator, specially in those parts of the country where the soil is deficient in phosphates. In this respect bones constitute a good fertilizing

* The writers have recently come across an interesting reference on the disintergration of bones by alkalies in N. G Mukherji's "Handbook of Indian Agriculture" (Third edition, p. 127). "Bones* * * may be reduced to powder by means of caustic lye (solution made out of ashes), quicklime or freshly calcined wood ashes. A simple plan is to pack the bones layer by layer, with freshly calcined wood ashes, in a barrel, and keep the mixture moistened for some months."

"A quicker method is to boil the bones in an iron or copper boiler with strong caustic lye The proportion of bones and lye to be used is roughly fifteen parts by weight of bones to five parts by weight of caustic soda or seven parts by weight of caustic potash dissolved in fifteen parts by weight of water The boiling should be done for two or three hours. But even without boiling the bones would become distintegrated, being simply kept in the caustic liquor for about a week."

In the Pusa experiments much less amounts of caustic soda are used (6 to 8 per cent. on bone). The process recommended by Mr. Mukherji uses 33 per cent.

material, but the cultivators do not use it, and large amounts are exported to the foreign countries. One of the important reasons why bones do not find favour with the agriculturist is due to their refractory nature. He finds it very difficult with the means at his command to reduce them to a condition sufficiently fine to be of utility as a fertilizer.

Experiments are being conducted at Pusa to find out simple means of disintegrating bones. Subjecting bones to steam under pressure yields a good product. Promising results have also been obtained where bones have been treated with solutions of mixtures of caustic alkali and common salt. Another line of attack is being followed where bones are fermented with the addition of composting materials.

# AMMONIUM PHOSPHATES AS FERTILIZERS FOR TROPICAL SOILS WITH SPECIAL REFERENCE TO INDIA AND CEYLON.

BY

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## I. Introduction.

Although phosphates of ammonia have for many years been well known to the chemist, it is only during the last ten years or so that they have become important on a commercial scale as fertilizers. Their development has been a post-war one, paralleled by the increase in the production of fertilizers incorporating nitrogen derived from the atmosphere. " Synthetic nitrogen ", as it is often imperfectly called, has been the leader in a number of progressive movements in the world of fertilizers, and undoubtedly the most significant of these movements has been the linkage of ammonia with another plant food, phosphoric acid.

It is not intended in this article to expound the advantages of the combined or compound type of fertilizer. It is obvious, after very little consideration, that if ammonia is joined with phosphoric acid instead of sulphuric acid, or, putting it in another way, if the treatment of insoluble forms of phosphoric acid to render them water-soluble can be modified to allow of the replacement of the carrier material by ammonia, economies are immediately effected in several ways. Economies in production make possible the marketing of fertilizers with unit values at their lowest, whilst economies in storage, by reason of reduced bulk, as well as in handling, freight and application, are immediately apparent when one considers that the plant food contained in one ton of pure di-ammonium phosphate can only be supplied by *one* ton of ammonium sulphate and *three* tons of superphosphate.

The main aim of this article is to consider the compound fertilizer from the point of view of performance, in an endeavour to arrive at its significance at present and if possible in the future, to the man who requires plant foods for his crops. It should be realized at the outset that the term " compound fertilizer ", or " compound type of fertilizer ", has rather a wide scope, but its use becomes necessary in view of the impossibility of employing a name that is based simply on an originally chemical one, as for instance " muriate of potash "—derived from

potassium chloride or muriate. From the chemical point of view it may be pointed out that there are several phosphoric acids (using the term in its true sense) and in the same way there exist a number of phosphate combinations. Thus we have mono-calcic phosphate—$CaH_4(PO_4)_2$, di-calcic phosphate—$Ca_2H_2(PO_4)_2$, and tri-calcic (basic) phosphate—$Ca_3(PO_4)_2$, all of which are phosphates in which calcium replaces in part or whole the hydrogen in the ortho-phosphoric acid $H_3PO_4$. It is well known to agriculturists that the preparation of superphosphate from a rock phosphate entails the conversion of the tri-calcic or insoluble form to the mono-calcic or water-soluble form.

In the same way it is possible to produce more than one combination of ammonia and phosphoric acid. The preparation of these combinations, to present them in the form and with the texture that makes them suitable for use as fertilizers, is still a matter of experiment, and specifications for the production of ammonium phosphates are still a notable feature of industrial journals dealing with the fertilizer trade.

Pure mono-ammonium phosphate contains 61·7 per cent. phosphoric acid and 12·2 per cent. nitrogen, whilst pure di-ammonium phosphate contains 53·8 per cent. phosphoric acid and 21·2 per cent. nitrogen. It is, of course, only rarely that a pure product is possible on a commercial scale, and the ammonium phosphates which are now on the market provide percentages of plant foods which only approximate to these figures. In addition it will be seen that these pure materials contain a large preponderance of phosphoric acid, and the average manurial scheme requires the supply of a greater proportion of nitrogen. It can be argued that mixing with a nitrogenous fertilizer soon adjusts matters, but such mixing is one of the processes which the compound fertilizer aims at making unnecessary, and manufacturers have, therefore, endeavoured to add to the nitrogen content of the compound fertilizer itself in the process of manufacture. The usual procedure has been to replace part of the phosphoric acid with sulphuric acid, so that the ultimate product really becomes an intimate mixture of sulphate and phosphate of ammonia. In some of the "compounds" on the market it is possible to recognize sulphate of ammonia crystals separately from those of the phosphate, but in the more successful materials the precipitation from double solution is carried out in such a manner as to provide a material that is homogeneous in texture. The use of the word "compound fertilizer" for such material as this might be objected to by the pure theorist, but it is a difficult matter to suggest an alternative term that can be used in practice. At present it is usual to produce two or more grades providing different ratios of N : $P_2O_5$. On the Continent several grades of "Nitro-Phos-Ka" (which includes also potash) are known. In America, two grades of "Ammo-Phos"

have been used since 1918, and since this is the material which provides practically all our information on the use of compound fertilizers in India and Ceylon, one can note here that the ratios of N : $P_2O_5$ which they provide are 10·7:46 and 16·5:20. During the last few months two grades of "Nici-Phos", presumably produced in England, have appeared, whilst during the last few years such materials as "Leuna-Phos", "Monammon-Phos" and "Diammon-Phos" were marketed on a small scale in India.

## II. Experiments with compound fertilizers.

In considering the usefulness of these fertilizers one is perhaps apt to regard them purely as novelties, to the exclusion of the fact that they are sound sources of ammonia and phosphoric acid. If a certain amount of ammonia and water-soluble phosphoric acid is known to be successful on a certain crop there is no logical reason for doubting the usefulness of a compound fertilizer which supplies the same amounts of both plant foods. The material with which the ammonia is combined makes no difference to the fact that it is ammonia, whilst water-soluble phosphoric acid remains so whether it be combined with ammonia or calcium in the mono-calcic form. Whilst such a view may appeal to the scientist it is not so easy to convince the consumer that this is the case, when it comes to the replacement of fertilizers with which he is accustomed to deal, by fertilizers which, by reason of their variation in manufacture, must be marketed under proprietary names. In addition the consumer wishes to know whether any difficulties arise in the use of the compound fertilizers which were not known to him with the old forms. It is such principles as these, no doubt, which underlie the trials which have been made by agricultural scientists and are still being made, in which the compound fertilizer is compared in performance with the old types.

In America a good deal of work has been carried out with Ammo-Phos from the year 1918 onwards, and may be said generally to point to the fact that the performance of such combined plant foods is very little different from that of mixed fertilizers. If anything, the combined form has shown a slight superiority, the reason for which is referred to later. In England there has not so far been any interest in the compound fertilizer. This is probably due to the fact that none of the principal manufacturers have been interested in the production of compound fertilizers until recently, whilst the influence of the Continental and American manufacturers has as yet had little effect. Notwithstanding this, the following experiments [Garner, 1930] can be quoted from Rothamsted and Woburn in 1927 and 1928 respectively. In the first trial mono-ammonium phosphate gave a yield of swedes that was as good as that with sulphate of ammonia and

superphosphate. The yield was in fact slightly greater, but not significantly so when treated statistically. At Woburn the yield of potatoes using a mixture containing di-ammonium phosphate was not significantly different from that in which the phosphoric acid was provided by superphosphate.

These experiments from Rothamsted and Woburn can probably be taken to mean that, whilst compound fertilizers have as yet no extensive use in England, agriculturists are aware of the possibilities which exist regarding their future. This must be the attitude of all agriculturists whose outlook is sound and rational.

There is a certain amount of evidence in India and Ceylon, which goes to show that ammonium phosphate can be regarded as equally efficient as sulphate of ammonia *plus* superphosphate, whilst some practical factors may make the use of a compound preferable. Most notable is the work of Hendry [1928 and 1930] with Ammo-Phos, Leuna-Phos and Diammon-Phos as fertilizers for paddy in Lower Burma.

These experiments were started in 1927-28 and continued in the following year, and the evidence provided deals with the crop manured and the residual manurial values to the following crops. In the first year Ammo-Phos only was used and briefly one can say that the increase in grain, using 50 to 300 lbs. per acre of the 20-20 grade, ranged from 47·7 to 118·6 per cent., all of which were sound economic returns. The residual value of these dressings to the following crops were shown by increases of from 6·9 to 12·3 per cent. When the 13-48 grade was used, in the first year the increases from dressings of 50 to 300 lbs. per acre ranged from 28·6 to 72·9 per cent., all of which were again profitable. The residual values of the 13-48 grade were naturally higher by reason of the greater proportion of phosphoric acid, and gave increases of from 3·7 to 27·1 per cent. In the second year also, Leuna-Phos used at rates varying from 50 to 400 lbs. per acre gave increases in grain of 39·2 to 200 per cent. and Diammon-Phos at 150 lbs. per acre gave an increase of 110·9 per cent. Most notable, however, is the fact that when two compound fertilizers (Ammo-Phos, and Diammon-Phos to which some Leuna-Phos had been added) were used to supply the same amounts of nitrogen and phosphoric acid as a mixture of sulphate of ammonia and superphosphate, the yields in all three cases were not significantly different. Hendry commenting on the results states that the proportion of N: $P_2O_5$ for paddy in Burma should be about 1:1 (from this point of view some of the grades of ammonium phosphate produced meet the case admirably). Referring to these experiments and others in Burma, Hendry remarks that "enough (information) has been obtained to make it safe to recommend them to the cultivator under suitable conditions........there appears

to be no doubt that the profitable manuring of rice will depend in future on this type of fertilizer."

This, then, gives the information which is wanted. The compound fertilizer in this instance is proved to be a material of practical value, and one which compares well in performance with ammonia and phosphoric acid in the old forms.

Other information is available from various sources which shows the compound fertilizer to be quite suitable for cultivators' crops in India. In Bihar and Orissa a small dressing of a compound fertilizer has been very successful on poor paddy lands [Clouston, 1928 ; Clouston, 1929 ; Cliff, 1930], and a recommendation regarding Ammo-Phos 20-20 grade is the subject of a leaflet issued by the Department of Agriculture [1928]. In Travancore, Ammo-Phos was tried soon after its introduction into India, and was very favourably reported on by the Department of Agriculture [1927-28]. A number of trials have since been made at the Paddy Experimental Stations at Nagercoil and Eraniel, and these provide evidence wholly in support of the compound fertilizer. In Mysore also the Agricultural Chemist has commented very favourably on the conduct of Ammo-Phos in trials on sugarcane and paddy [Mysore Department of Agriculture], and in trials conducted by the Mysore Experimental Union [1930] compound fertilizers have given results fully as good as those with mixtures of fertilizers. It is notable also that the Economic Botanist in Ceylon included compound fertilizers in his experiments on paddy [Lord, 1930], and the evidence obtained leaves no doubt as to their usefulness. It is unnecessary to quote in detail from these trials, and references are appended. The main point which evolves is that in all trials so far reported there is not a single instance of a compound fertilizer giving results which can be considered inferior to those where the plant foods have been provided by separate fertilizers. It is true that the trials referred to are in the main connected with rice, and further information is certainly required regarding the usefulness of compound fertilizers with other crops. Experiments are at present being conducted with coffee at the Balhonnur station [Coleman, 1930], and it is to be presumed that similar work will eventually be undertaken at the tea and rubber experimental stations in India for the information of planters. The present may appear a bad time at which to discuss questions of manuring, since it may be argued that this only tends to aggravate the present difficulties, largely brought about by over-production. At the same time it is necessary to realize that manuring is one of the factors making for reduction in the cost of production, and the remedy for over-production lies in other directions, and not in the removal of this factor. It is quite certain that manuring is a practice which must be continued ; it should therefore be the policy of all agriculturists to arrive at the most economical manuring for each particular

crop. On this point the compound fertilizer must come in for consideration if it can be shown to be capable of good performance. Meanwhile, in India, some thousands of tons of compound fertilizers are being sold every year, although the introduction of the first of them only took place two or three years ago. This, too, is in spite of the extraordinarily depressed agricultural conditions, and it would seem therefore that the compound fertilizer is attaining a certain amount of popularity for the "manuring crops", paddy, sugarcane and plantains. It may be remarked also that information is available regarding the use of Ammo-Phos on crops such as tobacco, sugarcane, etc., in other tropical countries, and it would seem that the compound fertilizer is an excellent proposition on most tropical soils.

## III. Theoretical considerations.

It will be observed that in arriving at the value of the compound fertilizer, experimenters have, in the main, used a mixture of sulphate of ammonia and superphosphate as a standard for comparison. This is a perfectly logical attitude. One can only compare comparable things, and it is therefore necessary to utilize for standard purposes the "elementary" fertilizers which contain ammonia and phosphoric acid, whose value to crops, within limits, is known. It is however necessary to consider whether the comparison entails any factors which may affect performance other than the presence of plant foods.

In referring to the work in America it was remarked that the experimental work had pointed to a slight superiority of the compound fertilizer over the mixture. At first it would appear that there is no logical explanation for such a slight difference, and it would seem to be due to experimental error only. When however the slight superiority, which must be neglected in individual experiment, is repeated in a number of experiments over a large area, it is necessary to pay some attention to the point, even though it may be only a small one. Exact experiments are needed to give some confirmation before it can be definitely asserted that such a superiority in performance actually exists, but at present it can be said to be well within the region of possibility.

In looking for an explanation for this superiority, one must first turn to the composition of the materials concerned. The great difference lies in the presence of the sulphate radical in ammonium sulphate, and calcium sulphate of the superphosphate, and its absence or prèsence to a lesser extent in the compound fertilizer. This has proved the crux of many a controversy on the subject of effect on soil acidity, but even accepting the view that continued use of sulphate may adversely affect soil acidity, such a factor is hardly likely to influence an individual yield in the first instance. It is more likely that the difference in performance

may be connected with movements of phosphoric acid in the two forms when applied to the soil. Work by Waynicke and Leavitt [1930] in California has given a possible line on which to work. Thay have found that, whereas scientific view is that phosphoric acid from superphosphate is fixed in the first few inches of soil, when the phosphoric acid has been combined with ammonium it is capable of reaching a considerable depth in soil. In one instance after several applications traces of water-soluble phosphoric acid were found at a depth of three feet in a clayey loam.

Definitely comparative experiments are needed, but if it can be established as characteristic of the phosphoric acid of ammonium phosphate that it is capable of penetrating to a greater area of the root-zone of plants than that of calcium phosphate, then the slight superiority of the compouud fertilizer over the mixture might be taken to be explained.

## IV. Practical considerations.

Hendry in Burma found that paddy required nitrogen and phosphoric acid in the ratio of 1: 1, and from manurial recommendations in the rest of India it would seem that agriculturists in the main agree with this ratio for the other big paddy areas. At present there are at least two compound fertilizers marketed which supply ratios closely approximating to 1:1, whilst it is to be supposed that if a variation from this figure were found to be necessary on a large scale, the necessary modification could be carried out in manufacture. It is true that there are areas where the soil requires a greater proportion of phosphoric acid. These are largely catered for by the unmodified type of compound fertilizer. Where more nitrogen is required, it is necessary to add a nitrogenous manure, but as cakes, when cheap, are very popular in paddy areas, this imposes no great difficulty. Where cakes are not used, a nitrogenous fertilizer such as sulphate of ammonia or cyanamide can be used. In the main, however, the 1·1 ratio is the one which is employed and the compound fertilizer can be self-sufficing.

For such crops as sugarcane and plantains, it is usual to employ a large amount of nitrogen up to 120 lbs. per acre with a small proportion (about a third) of phosphoric acid. With such a large dressing, it becomes necessary to make the application in two or three doses. Phosphoric acid and a certain amount of the nitrogen should be applied early, and the remainder of the nitrogen as side dressings. The compound fertilizer therefore becomes very suitable for the early dressing with the complementary applications of cakes, cyanamide, sulphate of ammonia, or nitrate of soda, following later.

In the case of crops where fruiting is the main factor to be considered, successful manuring hinges largely on the phosphoric acid applied, with very careful regulation of the nitrogen. A small proportion of nitrogen is, however, necessary in most cases, and the compound fertilizer which approximates to true ammonium phosphate is therefore very suitable. The same can be said of leguminous crops, in which case (as for instance groundnut) a small application of nitrogen helps materially in making good growth in the early stages. whilst a heavy application is not necessary.

For planting crops, it can be said that the available evidence regarding coffee points to the suitability of a $N:P_2O_5 : K_2O$ ratio of about 2:3.4. No compound fertilizer at present marketed supplies this ratio, but if a dressing first of the high-phosphate type is given, followed by one of the more balanced type, the correct ratio is soon obtained. For tea. the rate of application varies considerably with local practice, but in general it can be taken that the dressings which are given provide nitrogen and phosphoric acid in roughly equal quantities. The pruning mixture tends to be more of quickly available plant foods, and the general mixture rather of the prolonged-action type with emphasis on the supply of nitrogen. In the former, the compound fertilizer alone approximates to the correct ratio, whilst in the latter, the compound fertilizer can be used to advantage in mixtures containing cakes, rock phosphates, etc.

It will be seen therefore that the ratios of nitrogen-phosphoric acid provided in the ammonium phosphate type of fertilizers which are at present available, are well-suited to manurial practice applying at present with the main crops of India and Ceylon. The actual facility of manuring which is allowed by the compound fertilizer can be well represented in the consideration that a pure mono-ammonium phosphate gives a $N:P_2O_5$ ratio of 1:5, whilst in practice compound fertilizers are provided with ratios of about 1:1. This range provides a sufficient variation for the needs of most crops, and when necessary a purely nitrogenous fertilizer can be added to provide a predominance of nitrogen.

Reference so far has been made only to ammonium phosphates. It must be realized that a number of other compounds are becoming commercial possibilities. The Nitro-Phos-Kas are already well known, and similar grades of compound fertilizers incorporating potash have recently appeared in America under the name "Ammo-Phos-Ko". On the Continent, such materials as potassium phosphate, ammonium nitrate and double ammonium sulphate-nitrate are continually being experimented with, and may be expected to play a part in manuring in the future. From the practical point of view, however, it seems that ammonium phosphates are the most important of the new compounds, to the agriculturists of India and Ceylon,

and the extension of their use is likely to be one of the most notable developments of the future.

## V. Summary.

Ammonium phosphates, varying in composition according to their chemical make-up and mode of manufacture, are being marketed on an increasing scale.

Experiments have been carried out with them in America and other countries, whilst research authorities in England appear to be alive to their possibilities. These experiments show, and are confirmed by work carried out in India during the last few years, that the ammonium phosphate type of fertilizer can be substituted for the "elementary" or single plant-food fertilizers, with no detriment to yield.

There is some possibility that phosphoric acid which is combined with ammonia may be more effective than that combined with calcium by reason of greater penetrative power.

The proportions of nitrogen and phosphoric acid supplied by compound fertilizers at present marketed comply well with current manurial practice in the tropics.

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# THE INTENSIVE USE OF FERTILIZERS AND ITS EFFECT ON THE COMPOSITION OF THE SOIL CLAY.*

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The quality of seed being satisfactory, the supplies of nutrients and water in the soil being adequate, plant growth depends on a number of bio-chemical processes in the soil which in their turn are conditioned by its physico-chemical properties. The latter are believed to be due mainly to the colloidal matter present in the soil. The magnitude of these properties appears to depend on the reactivity of this soil fraction.

The fertilizers that are added to the soil are held by the clay by a process of surface absorption that prevent their being washed down into the deeper layers of the soil. This process of absorption of fertilizer and other salts is generally attended with exchange of bases, so that while certain ions are held in a state of absorption, certain others are disengaged and thrown into the soil solution. For instance, when a solution of ammonia or its salts is added to the soil the ammonia is absorbed by the clay and lime is disengaged. The physico-chemical properties of the soil depend on the nature and extent of the base exchange.

The exchange of bases by the soil has been under study in recent years. As a direct consequence of the knowledge of base exchange, we are now in a position to understand better the several reactions that take place in the soil on the addition of fertilizers, the causes for the formation of alkaline soils and rational methods of amelioration and in general to understand and, if possible, to control some of the ways of maintaining soil fertility.

Judging from the large volume of work that is being done on the subject of base exchange in all countries, it would appear that this aspect of soil research holds the key position to many problems of manuring and plant nutrition.

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The effect of intensive use of fertilizers on the quality of the clay complex has been under study. The material for the study was obtained from the old and new permanent manurial plots of the Central Farm, Coimbatore. The older set of plots have been under intensive cultivation and manuring for nearly twenty years, while the newer ones for only three years. The soil of the older plots is a brown loam and that of the newer plots is black and clayey. The plots are manured and cropped according to the following scheme. The plots are ten in number. Seven of these receive artificial fertilizers, *i.e.*, nitrogen, phosphoric acid, and potash, alone or in combination, while two plots are treated with cattle manure and one is not manured at all.

The general scheme of manuring is as below :—

| *Plot* | *Manure* |
|---|---|
| 1. (No) | No manure |
| 2. (N) | Nitrogen. |
| 3. (N *plus* K) | Nitrogen plus potash. |
| 4. (N *plus* P) | Nitrogen plus phosphate. |
| 5. (N *plus* K *plus* P) | Nitrogen plus potash plus phosphate. |
| 6. (K *plus* P) | Potash plus phosphate. |
| 7. (K) | Potash. |
| 8. (P) | Phosphate. |
| 9. (C M.) | Cattle manure (continuous). |
| 10. (C. M. R.) | Cattle manure (application stopped since 1916 and therefore residual). |

The nature and amounts of manures in use have been :—

| | |
|---|---|
| Ammonium sulphate | 1 cwt per acre for nitrogen. |
| Potassium sulphate | 1 cwt. per acre for potash. |
| Superphosphate | 3 cwts. per acre for phosphate. |
| Cattle manure (a mixture of dung, urine and litter) | 5 tons per acre. |

The plots have been under intensive cultivation from their inception with a view to emphasize the differential action of the manures. All crops are grown under irrigation. The crops usually grown are *ragi* (*Eleusine coracana*), *cholam* (*Andropogon Sorghum*), *pani varagu* (*Panicum miliaceum*), wheat (*Triticum vulgare*) and occasionally cotton and tobacco.

The scheme of manuring and fertilizer combinations and cropping in the New Permanent Manurial Plots is the same as mentioned above. Only the area is divided

into two series, eastern and western. Subsequent to the collection of soil samples which form the subject matter of this paper, the plots in the western series receive artificial fertilizers on light dressings of cattle manure.

In the present paper the discussion is confined to the effect of artificial fertilizers on the composition of the soil clay. The influence of organic manures like cattle manure, green manure and oil-cakes will form the subject of a later communication.

The soils from the different plots were examined for the nature and amount of replaceable bases contained in them. Good soils are generally characterised by a certain amount of richness in their replaceable lime which alone would constitute 80 to 90 per cent. of the total bases. Continuous manuring of such soils with ammonium sulphate and muriate of potash would be continuously reducing the relative proportions of replaceable lime. and the general condition of the soil may in consequence deteriorate.

The object of the analyses is to see to what extent this process has advanced in the various plots and the order of effectiveness, if any, of the manurial treatments in bringing about this change. The results of analyses are given in the tables appended (pp. 175-176).

## Statistical examination.

Confining our attention to the values for lime alone, it will be seen that differences are obtained between the different treatments. The figures being single-values, it would be difficult to say how much of the differences can be attributed to the effect of the fertilizers and how much to the inevitable errors of sampling the plots. One reasonable assumption could, however, be made and that is, that each of the fertilizers is independent in its action and, in the combinations, the effects of each individual fertilizer are only superimposed on those of the others. We could then group the various figures. as under, and apply to them statistical tests of homogeneity.

| Group (i) *Nitrogen* | Group (ii) *Potassium* |
|---|---|
| (N) *minus* (No manure). | (K) *minus* (No manure). |
| (N *plus* K) *minus* (K). | (N *plus* K) *minus* (N). |
| (N *plus* P) *minus* (P). | (K *plus* P) *minus* (P). |
| (N *plus* K *plus* P) *minus* (K *plus* P). | (N *plus* K *plus* P) *minus* (N *plus* P). |

The values according to this grouping are as below :—

*Old permanent manurials—surface soils.*

| | *Nitrogen group* | *Potassium group* |
|---|---|---|
| | + 2·6 | —0.3 |
| | + 0·6 | −1·5 |
| | + 1·5 | −2·3 |
| | + 2·2 | —2·2 |
| Mean | + 1·58 | —1·68 |
| Standard error of mean | ±0·57. | ±0·47 |

Standard error of mean difference ±0·74

t (Fisher's) = 4·54. n = 6.

The probability that the two groups are samples of one population is very small (smaller than 0·01).

*Old permanent manurials—sub-soils.*

| | | |
|---|---|---|
| | —0·4 | +1·2 |
| | +1·2 | +0·4 |
| | +1·8 | +0·0 |
| | +1·6 | +0·2 |
| Mean | +1·05 | +0·45 |
| Standard error of mean | ± 0·51. | ±0·23 |

Standard error of mean difference ±0·55

t = 1·1. n = 6.

The probability that the two groups are samples of one population is high.

*New permanent manurials—surface soils.*

| | *Nitrogen group* | *Potassium group* |
|---|---|---|
| | +0·5 | +0·2 |
| | —0·8 | +1·5 |
| | +0·5 | —1·1 |
| | +2·4 | —0·4 |
| | +0·9 | +4·0 |
| | —3·7 | —1·5 |
| | +0·6 | —0·6 |
| | −1·2 | +0·3 |
| Mean | —0·1 | +0·3 |
| Standard error of mean | ± 0·64. | ±0·62 |

Standard error of mean difference ±0·89

$$t\ (\text{Fisher's}) = \frac{0{\cdot}4}{0{,}89} = 0{\cdot}447\ ;\ n = 14.$$

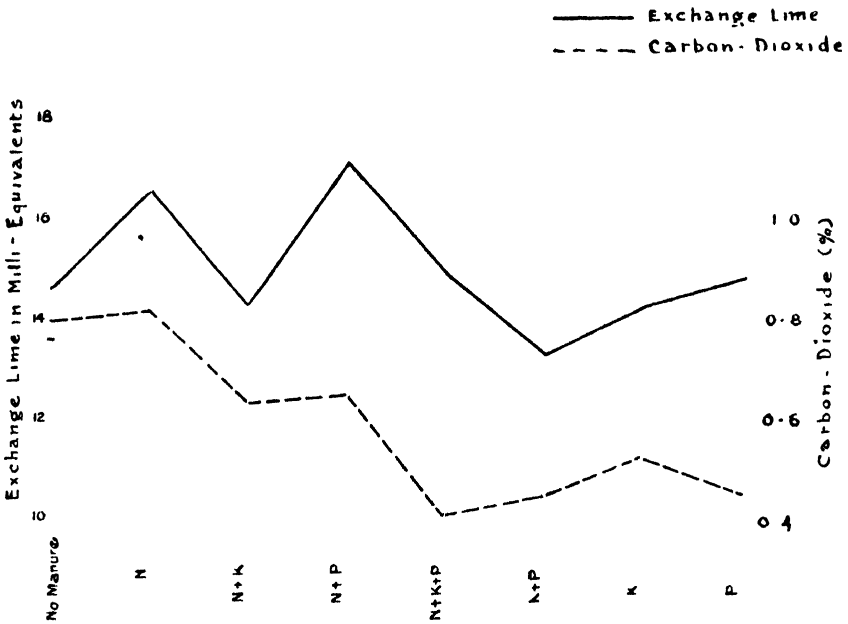
The probability that the two groups are random samples of one population is high (between 0·70 and 0·60).

It is seen that in one set the figures yield groups that are statistically distinguishable and are, therefore, derived from two different populations. The figures obtained for the new permanent manurial plots constitute homogeneous groups, showing that the influence of the fertilizers is hardly felt at all. Those for the old permanent manurial plots, on the other hand, yield groups that are statistically units of two different populations. This is evidence of the fact that intensive fertilization does change the basic composition of the clay and therefore its general condition.

An examination of the figures for the effects of the individual fertilizers gives some interesting results. H. J. Page and Williams [1924-25] examining the soils of the Rothamsted Experiment Station has classified fertilizers in the order of their increasing powers for replacing calcium. Applying this criterion to the various fertilizer treatments, the results for lime, expressed as per cent. of the total replaceable bases, may be arranged in the following order :—

| Class | I | | II | | III | | IV | |
|---|---|---|---|---|---|---|---|---|
| (a) | (P) | 60·1 | (No) | 62·7 | (K *plus* P) | 58·3 | (K) | 56·3 |
| (b) | (N *plus* P) | 63·1 | (N) | 65·1 | (N *plus* K) | 62·4 | | |
| | | | | | (N *plus* K *plus* P) | 61·6 | | |

The results agree with those of Page. It will be seen that the greater the replacing power of the fertilizer, the greater has been the replacement. In further support of this, the amount of calcium carbonate present may be considered to indicate the total demand on soil lime due to the replacement. Assuming the different plots to have contained the same quantity of carbonate before the experiment started, the reduction due to twenty years of fertilizer application should be proportional to the demand. That this is so, is seen from the graph attached.




There are, however, some differences between our results and those of Rothamsted. The latter are for entirely discounting ammonium sulphate as a calcium-replacing agent on the ground that ammonia rapidly disappears from the soil by nitrification. Our results would appear to indicate the contrary view in regard to what may be called the lime status of the clay complex. The ammonium sulphate treated plots (group b) contain a greater proportion of exchangeable lime than the corresponding non-ammonium sulphate treated plots (group a).

There are two possible explanations. The one is that the ammonium sulphate treated plot being located at one end of the experimental block had had the advantage of an initial start of a higher lime status than the others. The other explanation is that the nitric acid resulting from the oxidation of ammonia in ammonium sulphate had acted on the calcium carbonate reserves of the soil and maintained in the soil solution of these plots a higher level of calcium concentration, with the result that the exchangeable lime of the original soil in general has had a less active role in exchange reactions and is, therefore, better preserved in the clay complex itself. We are inclined to the latter view, and support to this is obtainable from certain of our other experiments where soil-solution studies of

soils to which different manures had been applied were made. The relevant portions of the results are :—

| Fortnightly round of analyses | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| | CaO as parts per million of soil. | | | | | |
| Unmanured plots . . | 36·4 | 22·4 | 28·3 | 27·3 | 40·2 | 28·5 |
| Ammonium sulphate plots . | 62·3 | 51·1 | 28·2 | 70·2 | 65·2 | 58·6 |

The lime in soil-solution of the ammonium sulphate plots is always higher than that of the untreated plots.

It will be seen from Table II that a statistical analysis of the results for the sub-soils from the old permanent manurial plots does not give statistically distinguishable groups, showing that the differential fertilizer treatments have not affected the sub-soils. This state of the sub-soils may be taken as a rough indication of the condition of the soil before the experiment began. Similar results were obtained by Ogg and Dow [1928] with certain Scottish soils, and by W. H. Metzger [1930] in America.

Another interesting point is that the soda content of the clay-complex of the soil from new permanent manurial plots is higher than that of the old permanent manurial plots whose soil is lighter, more easily worked and better drained than that of the new permanent manurials. The limits up to which the depletion of lime from, or the entry of soda into, the clay-complex could be allowed to proceed with safety, is under investigation.

## Summary.

The influence of intensive manuring with artificials on the exchangeable bases of soils are studied.

These influences are confined only to the surface layer of the soil.

Agreement with Page and Williams is obtained when these manures are arranged in the order of their lime-replacing powers except in the case of ammonium sulphate

An alternative theory of the action of ammonium sulphate is put forward and evidence in support of the same is advanced.

## References.

Metzger (1930). *Soil Science* **29**, 251.

Ogg and Dow (1928). *J. Agric Science* **18**, 181.

Page and Williams 1924-25). *Trans. Faraday Soc.* **20**, 573-85.

## REPLACEABLE BASES OF THE OLD AND NEW PERMANENT MANURIAL PLOTS. (EXPRESSED IN MILLIGRAM-EQUIVALENTS PER 100 GRMS. OF AIR-DRY SOIL).

### TABLE I.

*Old Permanent Manurials—Surface soils.*

| | Lime | Magnesia | Potash | Soda | Lime / Total Bases per cent. |
|---|---|---|---|---|---|
| No manure . . . . | 14·6 | 6·6 | 0·3 | 1·8 | 62·7 |
| N . . . . . . . | 16·6 | 6·7 | 0·3 | 1·9 | 65·1 |
| N *plus* K . . . . . | 14·3 | 6·3 | 0·4 | 1·9 | 62·4 |
| N *plus* P . . . . . | 17·1 | 7·5 | 0·2 | 2·3 | 63·1 |
| N *plus* P *plus* K . . . . | 14·9 | 7·2 | 0·4 | 1·7 | 61·6 |
| K *plus* P . . . . . | 13·4 | 7·4 | 0·5 | 1·7 | 58·3 |
| K . . . . . . . | 14·3 | 8·4 | 0·6 | 2·1 | 56·3 |
| P . . . . . . . | 14·9 | 7·3 | 0·3 | 2·1 | 60·1 |

### TABLE II.

*Old Permanent Manurials - Sub-soils.*

| | | | | | |
|---|---|---|---|---|---|
| No manure . . . . . | 7·0 | 6·6 | 0·2 | 2·4 | 43·2 |
| N . . . . . . . | 6·6 | 6·8 | 0·6 | 2·4 | 40·3 |
| N *plus* K . . . . . . | 7·0 | 6·9 | 0·3 | 2·9 | 40·9 |
| N *plus* P . . . . . . | 6·6 | 8·2 | 0·2 | 2·7 | 37·3 |
| N *plus* K *plus* P . . . . | 6·8 | 8·3 | 0·3 | 3·3 | 36·4 |
| K *plus* P . . . . . . | 8·4 | 8·3 | 0·3 | 3·1 | 41·8 |
| K . . . . . . . . | 8·2 | 8·9 | 0·5 | 2·5 | 40·8 |
| P . . . . . . | 8·4 | 7·9 | 0·2 | 3·0 | 43·0 |

## TABLE III.

*New Permanent Manurials—Eastern series—Surface soils.*

| | Lime | Magnesia | Potash | Soda | Lime / Total Base |
|---|---|---|---|---|---|
| | | | | | per cent. |
| No manure . . . . . | 16·3 | 7·1 | 0 8 | 5·9 | 54·2 |
| N . . . . . . . | 16·8 | 6·7 | 0·9 | 4·7 | 57·7 |
| N *plus* K . . . . . . | 15·7 | 6·6 | 1·0 | 4·3 | 56·9 |
| N *plus* P . . . . . . | 18·3 | 6·6 | 0·8 | 4·2 | 61·2 |
| N *plus* K *plus* P . . . . . | 17·9 | 6·1 | 1·0 | 3·9 | 61 9 |
| K *plus* P . . . . | 17·4 | 5·5 | 0·9 | 3·7 | 63 3 |
| K . . . . . . . | 16·5 | 6·0 | 1·1 | 3·9 | 60·0 |
| P . . . . . . . | 15·9 | 6·2 | 0·7 | 3 8 | 59 8 |

## TABLE IV.

*New Permanent Manurials—Western series—Surface soils.*

| | | | | | |
|---|---|---|---|---|---|
| No manure . . . . . | 14 4 | 7·5 | 0·8 | 5·9 | 50·4 |
| N . . . . . . . | 15 3 | 7·7 | 0 8 | 5 8 | 51·7 |
| N *plus* K . . . . . . | 14·7 | 7·6 | 0·9 | 5·4 | 51·4 |
| N *plus* P. . . . . | 17·4 | 7·2 | 0 8 | 4·8 | 57·6 |
| N *plus* K *plus* P . . . . . | 17·7 | 7·2 | 1·0 | 4 5 | 58 2 |
| K *plus* P . . . . | 17 1 | 7·3 | 0 8 | 4·2 | 58 2 |
| K . . . . . . . | 18·4 | 7·6 | 1·0 | 5·3 | 57·0 |
| P . . . . . . . | 18 6 | 7·5 | 0·8 | 5·3 | 57·8 |

# THE CHEMICAL STUDY OF THE EFFECT OF FROST ON CANE CROP AND *GUR*-MAKING FROM FROST-AFFECTED CANES IN THE DISTRICT OF AHMEDNAGAR IN 1929.*

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The cold wave which came on 31st January, 1st and 2nd February, 1929, damaged the cane crop enormously in the whole tract under the Godavari and Pravara Canals. The effect of this was seen in (1) drying up of the leaves, (2) burning of the top shoots, (3) rotting of the growing points (being an after-effect) with spread of rot from top downwards, and (4) sprouting of eye-buds in all-types of canes, *viz.*, plant cane, ratoon cane and Adsali cane (of June and July planting). The variety of cane grown is Pundia (a thick, soft, juicy cane). The temperatures recorded were as follows :—

| January 31, 1929 | | February 1, 1929 | | February 2, 1929 | |
|---|---|---|---|---|---|
| Max. | Min. | Max. | Min | Max. | Min. |
| 70°F. | 44°F. | 70°F. | 34°F. | 75°F. | 35°F. |

Owing to the damage being of different nature and severity in the different cases, study was taken up to investigate chemically in order to get a clear idea as to the causes of losses and the possibilities of remedying the same, if possible.

Early harvesting was inevitable, as the growth was stopped owing to the rotting of the shoot and sprouting of the eye-buds. There were no hopes for the affected canes to grow into a normal crop, but there was likelihood of the deterioration of the constituents of cane and juice. Experiments were conducted at Kopergaon, the centre of the affected area.

After examining a number of samples of affected and unaffected canes, it was found necessary to continue the tests to study the after-effects of frost on the con-

*Paper read at the Indian Science Congress, Agricultural Section, Nagpur, January 1931.

stituents. The following scheme was adopted to study these changes from day to day. Five plots were selected of ten gunthas (¼ acre) each of the following types of cane crops :—

(1) Plant cane (*suru*) of February planting—affected.

(2) Plant cane (*suru*) of February planting—unaffected.

(3) Ratoon cane (1st ratoon *khodwa*) March cutting—affected.

(4) Ratoon cane (1st ratoon *khodwa*) March cutting—unaffected.

(5) Adsali cane of June or July planting—affected.

There was no plot available under Adsali cane which was not affected. The term 'unaffected' is used in case of cane which showed no outward signs of damage that are enumerated above. The samples of canes just sufficient for one boiling (nearly 2,000 lbs. of stripped cane) were taken from the above plots separately on every fourth day for the first three trials and every eighth day for the next three trials. In all five samples were taken every time and six such trials were conducted, the dates being 20th, 23rd and 26th February and 5th, 12th and 19th March, 1929. The following determinations were made in the juice, *viz.*, (1) Brix, (2) glucose (reducing sugars), (3) sucrose (non-reducing sugars) and (4) acidity. Also the weight of cane per acre and weight of *gur* per acre were calculated for that day.

General record of the crop conditions and cane weights was kept. The juices from the above cane samples were boiled to *gur*, separately noting the weights and quality of *gur*. *Gur* samples also were analysed.

A great many samples of cane and juice from affected and non-affected canes were analysed from the different places in the affected area from the cultivators' fields to compare the results with those under control conditions.

### METHODS OF ANALYSIS.

The sugars have been estimated by the Fehling's volumetric modification method.

Acidity has been found by titrating with standard alkali using phenolphthalein as indicator, and is expressed in terms of grms. of KOH per 100 c.c. of juice and in case of *gur* per 100 grms. of *gur*.

### CONCLUSIONS OF EXPERIMENTAL TESTS.

*Purity*.—In all 33 tests were taken. It can be said in general that the purity was low (normal 86 to 92 ; in the affected canes 45 to 90), which could be attributed to :—

(1) The cane being premature for harvesting.

(2) The growth being arrested by frost.

PLATE XII.

Fig. 1. Ratoon cane unaffected by frost.

Fig. 2. Adsali cane affected by frost.

PLATE XI.

Fig. 1. Plant cane affected by frost.

Fig. 2. Plant cane unaffected by frost.

Fig. 3. Ratoon cane affected by frost.

(3) Burning of the growing point.

(4) Subsequent rotting of the shoot.

(5) Inversion of sucrose by sprouting of the dormant buds.

*Glucose.*—The percentage of glucose increased by 20 to 66. But there was no further increase in the amount as an after-effect to an appreciable extent compared with the unaffected canes (normal glucose 1 to 1·5 per cent. increased to 1·2 to 2·5 per cent.).

*Sucrose and Brix.*—There was a decided decrease in the percentage of sucrose (normal 17 to 18 per cent. decreased to 8 to 15 per cent.). This had a bad effect on the quality of juice and also on the quantity and quality of *gur* in case of both affected and unaffected canes. There was no regular fall in Brix (though the figures themselves are low) from day to day (the actual figures being, normal 18° to 20°, and changed figures 13° to 20°). The tests were started 20 days after the frost. There was a slight increase in Brix in case of unaffected ratoon.

*Acidity.*—The acidity generally speaking was not far from the normal and did not show much variation from day to day.

## CONCLUSIONS OF *GUR*-MAKING TRIALS FROM EXPERIMENTAL PLOTS.

There had been no defect in Brix reading from day to day but there was increase in certain cases up to 2·5°, though of course the Brix was below that which is found in a normal year. Yet in almost all cases there was lowering of yield in *gur* and also the quality of *gur* was rather inferior in every case but more pronounced in plant and Adsali canes.

This was due to the actual physiological effect of frost on cane crop, and as a result there had been inversion of sucrose and therefore comparative increase in glucose and also probably to the presence of higher amounts of albuminoids and other substances.

The proportion of *gur* to Brix was not constant and in most cases was lower than that which is usually found, showing that there was greater quantity of other soluble solids than sugars. This is a general fact seen from a number of trials done on the cultivators' fields.

There was no further loss in the quantity of *gur* or deterioration in juice as an after-effect of frost as observed from 20th February onwards. This was what was expected, as rotting did not continue beyond two to three internodes from the top.

The results of the trials are given in statements in the Appendix (p. 199). Photographs of the plots are given in Plates XI and XII.

## THE METHOD OF PREPARING *Gur*.

The following method of preparing solid marketable *gur* from the juice of affected canes was recommended to give relief to the cultivators in getting over the difficulties in *gur*-making from immature and frost-affected canes. Materials required for clarification are :—

(1) *Bhendi* or wild *bhendi* (*Hibiscus esculantus*) stalks. These are extracted with water, and the mucilage extract thus obtained is used. (4 plants extracted in 4 gallons of water for 1 pan.)

(2) Solution of *sajji-khar* (mixture of sodium bicarbonate, sodium carbonate and sodium sulphide), 5 per cent. solution.

(3) Lime water. (Quantity depending on the amount of acidity of the juice.)

### *The clarification or boiling of juice.*

The most important part consists in the proper boiling of the juice and in the removal of the scum efficiently before and after the clarifying agents are used. The first scum separates at 84°—88° C. when it should be removed, while the temperature should not be allowed to rise over 90° C. This is the stage before ebullition. After removing the first scum, the mucilage extract is added and fire is adjusted so as to keep the temperature near ebullition point when second scum collects. Heating should be done slowly so as to facilitate the *gur*-boiler to remove all scum. This is then completely removed and the temperature is raised above the ebullition *upla, i.e.*, to 92°—94° C. and maintained while the *sajji* water is added by sprinkling, according to requirements. Third scum separates out and bleaching of colour is effected to some extent. If the juice becomes quite clear, the boiling may be continued by the usual way. No further care is necessary except to remove the scum which collects in smaller bits. The pan should be struck at the proper temperature or at the proper *goli* stage.

As the use of the *sajji* solution and lime water depends upon the nature of the juice, it should be ascertained in the particular cases by trials and judged by the quality and type of *gur* that is produced. There is no general rule that can be laid down about the necessity and quantity of these materials to be used. But if above precautions are followed the *gur*-boiler can easily find out the quantities in a trial of one boiling and adjust the proportions accordingly.

When *sajji* solution is used there is no necessity for the addition of washing soda at all, as some *gur*-boilers are in the habit of using.

## APPENDIX.

### Plant cane affected. (Plate XI, fig. 1.)

This gives the results of eight trials taken with plant cane from the 20th February to the 2nd April, 1929. There were two extra trials taken on the 26th March and the 2nd April as the cane was available. The following are the figures of analyses of juice and the yields of cane and *gur* in lbs., calculated on acre-basis for that particular date.

*Statement I.*

Planted in February 1928. Variety of cane—Pundia.

| Date | Analyses of juice | | | | | Yields | |
|---|---|---|---|---|---|---|---|
| 1929 | Brix (corrected) | Reducing sugars (glucose) per cent. | Non-red. sugars (sucrose) per cent. | Acidity—in grms. of KOH per 100 c.c. of juice | Purity per cent. | Weight of cane per acre, lbs | Weight of *gur* per acre, lbs. |
| 20-2 | 17·64° | 1·743 | 15·474 | 0·077 | 87·22 | 69,986 (20-2 to 26-2) | 7,803 (20-2 to 26-2) |
| 23-2 | 14·95° | 2·187 | 10·534 | 0·089 | 68·81 | | |
| 26-2 | 15·36° | 1·109 | 11·643 | 0·077 | 75·80 | | |
| 5-3 | 16·74° | 2·262 | 12·173 | 0·061 | 72·75 | 68,970 | 6,586 |
| 12-3 | 15·67° | 1·817 | 10·906 | 0·094 | 69·60 | 74,651 | 6,606 |
| 19-3 | 15·33° | 1·605 | 9·274 | 0·055 | 60·52 | 75,083 | 7,808 |
| 26-3 | 14·30° | 2·106 | 10·660 | 0·061 | 74·54 | 67,673 | 7,139 |
| 2-4 | 18·23° | 2·175 | 11·906 | 0·083 | 65·30 | 64,847 | 4,766 |

**Purity is very low and is more or less on the side of decrease from day to day. Glucose is on the whole very high. The impurities in the juice are more. There was difficulty in getting *gur*.**

PLANT CANE UNAFFECTED. (PLATE XI, FIG 2.)

This table gives the results of six regular trials from 20th February to 19th March, 1929.

The following are the figures of the analyses of juice and of yields calculated on acre-basis for that date in point of weight of cane and *gur*.

*Statement II.*

Planted in February 1928. Variety of cane—Pundia.

| Date | Analyses of juice | | | | | Yields | |
|---|---|---|---|---|---|---|---|
| 1929 | Brix (corrected) | Reducing sugars (glucose) per cent. | Non-red. sugars (sucrose) per cent. | Acidity in grms. of KOH per 100 c. c. of juice | Purity per cent. | Wt. of cane per acre, lbs. | Wt. of *gur* per acre, lbs |
| 20-2 . . . | 17·43° | 1·866 | 13·812 | 0·089 | 79·24 | | |
| 23-2 . . . | 17·56° | 1·690 | 12·948 | 0·041 | 73·73 | 84,522 | 9,396 |
| 26-2 . . . | 15·25° | 1·534 | 10·325 | 0·066 | 67·88 | | |
| 5-3 . . . | 15·24° | 2·276 | 10·810 | 0·083 | 70·93 | 90,750 | 9,301 |
| 2-3 . . . | 17·09° | 1·595 | 11·688 | 0·105 | 68·39 | 98,892 | 11,075 |
| 19-3 . . . | 18·28° | 1·384 | 10·335 | 0·088 | 56·54 | 88,548 | 8,987 |

The purity is low comparatively. The Brix is below the normal. Glucose is rather much. The *gur* obtained is of rather inferior quality, though not so much lower in quantity.

RATOON CANE AFFECTED. (PLATE XI, FIG. 3.)

This statement gives results of six trials commencing on 20th February and ending on 19th March, 1930. The figures for *gur* and cane weight are calculated for that particular day on acre-basis.

*Statement III.*

Planted in—cut in March 1928. Variety of cane—Pundia.

| Date | Analyses of juice | | | | | Yields | |
|---|---|---|---|---|---|---|---|
| 1929 | Brix (corrected). | Reducing sugars (glucose) per cent. | Non-red. sugars (sucrose) per cent. | Acidity in grms. of KOH per 100 c. c. of juice | Purity per cent. | Wt. of cane per acre, lbs. | Wt. of *gur* per acre, lbs. |
| 20-2 . . . | 19 08° | 1·034 | 17·266 | 0·096 | 90 49 | 41,734 | 5,112 |
| 23-2 . . . | 19·10° | 1·415 | 10 534 | 0·077 | 55·15 | | |
| 26-2 . . . | 19·51° | 1 095 | 13·074 | 0 077 | 67·01 | | |
| 5-3 . . . | 18·88° | 1·415 | 14·140 | 0 083 | 74·89 | 64,403 | 7,953 |
| 12-3 . . . | 19·86° | 1·339 | 11·142 | 0·083 | 56·10 | 74,270 | 9,469 |
| 19-3 . . . | 19·55° | 1·192 | 8·862 | 0·083 | 45·33 | 51,304 | 7,054 |

Though the Brix is very high the quality of the juice is very low and so also the purity. Sucrose being low, the quality of *gur* obtained was inferior.

RATOON CANE UNAFFECTED. (PLATE XII, FIG. 1.)

This statement gives results of six trials from February 20th to March 19th. The analytical figures for juice are given; the cane weight and *gur* obtained from the boiling are calculated on acre-basis and are given for that particular day.

*Statement IV.*

Planted in—cut in March 1928. Variety of cane—Pundia.

| Date | Analyses of juice | | | | | Yields | |
|---|---|---|---|---|---|---|---|
| 1929 | Brix (corrected) | Reducing sugars (glucose) per cent. | Non-red. sugars (sucrose) per cent. | Acidity in grms. of KOH per 100 c. c. of juice | Purity per cent. | Wt. of cane per acre, lbs. | Wt. of *gur* per acre, lbs. |
| 20-2 . . | 17 67° | 1·590 | 10 436 | 0·096 | 59·06 | 72,923 | 8,799 |
| 23-2 . . | 18·37° | 1·585 | 13·128 | 0·083 | 71·46 | | |
| 26-2 . . . | 19·40° | 1·220 | 11·283 | 0·066 | 58·16 | | |
| 5-3 . . . | 20 88° | 1 618 | 15·363 | 0·066 | 73·58 | 75,793 | 10,269 |
| 12-3 . . . | 19·31° | 1·535 | 10·409 | 0·077 | 53·90 | 72,313 | 8,424 |
| 19-3 . . . | 20·10° | 1·673 | 12·540 | 0·061 | 62·39 | 72,600 | 8,131 |

Brix is on the increase and so also the purity. The quality of *gur* obtained was comparatively superior. There was not much defect in the yield.

### Adsali cane affected. (Plate XII, fig 2.)

This statement gives one more trial in addition to the six (on 26th March). The figures for *gur* weight and cane weight are calculated on acre-basis from the area cut for that boiling.

No plot for comparison could be obtained for this plot as practically the whole of the crop was affected, and not even a stray crop could be obtained in the locality which showed less damage. Besides this there is much variation in the time of planting of this cane (the age varying from 4 to 8 months and that of this cane being 7 months). This was another difficulty in getting a control for this plot.

*Statement V.*

Planted in July 1928. Variety of cane—Pundia.

| Date | Analyses of juice | | | | | Yields | |
|---|---|---|---|---|---|---|---|
| 1929 | Brix (corrected) | Reducing sugars (glucose) per cent. | Non-reducing sugars (sucrose) per cent. | Acidity in grms. of KOH per 100 c.c. of juice | Purity per cent. | Wt. of cane per acre, lbs | Wt. of *gur* per acre, lbs. |
| 22-2 . . . | 13·49° | 2·568 | 8 011 | 0·089 | 59·39 | | |
| 23-2 . . . | 14·93° | 1·823 | 8·072 | 0·089 | 54·13 | 46,826 | 4,604 |
| 26-2 . . . | 14·67° | 2·189 | 9·476 | 0·105 | 64·59 | | |
| 5-3 . . . | 14·22° | 2·493 | 8·959 | 0 105 | 63·00 | 54,004 | 5,130 |
| 12-3 . . . | 14·25° | 2·492 | 8·078 | 0·105 | 56·69 | 54,763 | 3,367 |
| 19-3 . . . | 14·83° | 2·027 | 9·375 | 0·097 | 63·22 | 45,787 | 4,189 |
| 26-3 . . . | 15·50° | 1·78 | 11·178 | 0 077 | 72·10 | 44,649 | 4,576 |

Both the purity and Brix are low. Glucose is very high as well as acidity, and hence the difficulty in getting *gur*. There is no further effect on the quality of juice due to frost.

ANALYTICAL DATA FOR PLANT, RATOON AND ADSALI CANES FROM CULTIVATORS' PLOTS.

The following statement shows the analysis of juice of the samples of affected canes sent by the cultivators. These are selected from cultivators' fields on both the canals to see the effect in the whole area.

*Statement VI.*

| Type of cane | Brix | Reducing sugars (glucose) per cent. | Non-reducing sugars (sucrose) per cent | Acidity in grms. of KOH per 100 c.c. of juice | Purity per cent. |
|---|---|---|---|---|---|
| Plant cane affected . . . . | 17·5° | 1·64 | 11·295 | 0·11 | 64·6 |
| Ditto . . . . . | 15·73° | 2·63 | 10·06 | 0·077 | 64·0 |
| Ditto . . . . . | 16·81° | 1·292 | 9·164 | 0·099 | 54·5 |
| Ratoon cane affected . . . . . | 17 53° | 1·639 | 9·62 | 0·149 | 54·8 |
| Ditto . . . . . . | 19 3° | 1·58 | 7 45 | 0·077 | 38 6 |
| Ditto . . . . . . | 19·42° | 1·033 | 10·104 | 0 068 | 52·3 |
| Adsali cane affected . . . | 13·85° | 2·388 | 6·723 | 0 11 | 48·6 |
| Ditto . . . . . | 13·66° | 3·435 | 6·777 | 0·16 | 49·6 |
| Ditto . . . . . | 13·77 | 3·36 | 7·39 | 0 11 | 53·7 |

On the whole the figures for Brix are slightly lower than the normal. The quality of the juice was not of the right sort. The percentage of the glucose being higher, good crystalline *gur* could not be obtained in these cases though solid *gur* was prepared out of these canes.

### Analysis of selected samples of gur from the trials taken.

The following table gives the figures of analyses of *gur* taken at an interval of 14 days since there seemed no difference in the intervening samples.

*Statement VII.*

| Name and date | Glucose per cent | Sucrose per cent. | Acidity KOH per 100 c.c. | Albuminoids per cent. | Nitrogen per cent. | Remarks |
|---|---|---|---|---|---|---|
| 20-2-29— | | | | | | |
| Plant cane A. . . | 17·93 | 58·44 | 0·38 | 1·69 | 0·27 | A.—Affected. |
| Ratoon cane A. . . | 14·29 | 64·06 | 0·37 | 1·28 | 0·20 | |
| Adsali cane A. . | 17·69 | 58·67 | 0·67 | 1·88 | 0·30 | |
| Plant cane UnA. . . | 15·38 | 70·29 | 0·36 | 0·85 | 0·14 | UnA.—Unaffected. |
| Ratoon cane UnA. . | 15·85 | 67·27 | 0·60 | 1·12 | 0·19 | |
| 5-3-29— | | | | | | |
| Plant cane A. . . | 16·99 | 63·54 | 0·56 | 1·44 | 0·23 | |
| Ratoon cane A. . . | 16·05 | 61·94 | 0·50 | 0·94 | 0·15 | |
| Adsali cane A. . . | 16·05 | 60·75 | 0·71 | 2·00 | 0·32 | |
| Plant cane UnA. . . | 16·56 | 63 95 | 0·39 | 1·00 | 0·16 | |
| Ratoon cane UnA. . | 15·95 | 63·26 | 0·35 | 0·81 | 0·13 | |
| 19-3-29— | | | | | | |
| Plant cane A. . . | 18·18 | 64·39 | 0·75 | 1·63 | 0·26 | |
| Ratoon cane A. . . | 12·44 | 73·35 | 0·47 | 1·22 | 0·195 | |
| Adsali cane A. . . | 16·25 | 57·21 | 0·70 | 1·23 | 0·196 | |
| Plant cane UnA. . . | 16·05 | 69·93 | 0·47 | 0·81 | 0·13 | |
| Ratoon cane UnA. . | 16·28 | 59·97 | 0·58 | 1·14 | 0·18 | |
| Misc. samples— | | | | | | |
| Plant cane A. . . | 20·00 | 66·26 | 0·56 | 1·00 | 0·16 | Treated with *bhendi*. |
| Plant cane A. . . | 22·41 | 58·39 | 0·73 | 1·69 | 0·27 | Not treated with *bhendi*. |
| Adsali Young A. . . | 16·15 | 69·82 | 0·78 | 1·25 | 0·20 | |
| Nidwa A. . . . | 21·31 | 62·09 | 0·50 | 1·14 | 0·18 | |
| Ratoon A. . . . | 18·71 | 65·95 | 0·67 | 1·14 | 0·18 | |

On the whole it can be said that the quantity of glucose is higher by 15 to 20 per cent. from the normal and there is reduction of sucrose by about 25 per cent. in the affected canes as compared with the usual normal figure. Under the unaffected plant and ratoon the decrease is also seen because the wave had passed over the crop having damaging effect on the quality of juice, though for outward appearance there was no affection.

In the case of Adsali cane affection was the most which is vividly seen in lowering in the sugars and increase in the albuminoids. There was no crystalline appearance to the *gur* obtained from Adsali.

The figures of acidity do not vary much from the normal.

These *gur* samples were analysed in July 1929 (four months after the above experimental trials). The analysis could not be taken up earlier. This fact should be considered while reading these figures.

# SOIL CONDITIONS AS AFFECTING THE GROWTH AND MATURITY OF SUGARCANE IN THE DISTRICT OF SARAN.*

BY

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The district of Saran in North Bihar contains five sugar factories, and there are two others just beyond its border but which draw largely on the district for their supply of sugarcane. Sugarcane thus forms a very important paying crop here, and any condition that interferes with the proper growth and the maturity of the crop is well worth investigation.

The varieties of sugarcane that at present hold the field are the local canes, *viz.*, the Rheora and the Bhuri or Bhurli. They are, however, being largely ousted by the Coimbatore varieties, of which Co. 213, Co. 210 and Co. 205 form the chief favourites. The average yield of these canes per acre is 700 to 800 mds. for Co. 213, 600 to 700 mds. for Co. 205, 600 mds. for Co. 210, and 300 to 400 mds. for the local varieties. It is no wonder, therefore, that the heavy-yielding and quickly-growing Co. canes would naturally replace the local ones, and that Co. 213 would be the variety most liked. Of late years, however, there has been a set-back, for Co. 213 is being found yellowing and withering up at the end of the rains. The first indications are a pale appearance of the leaves which starts from the top moving down along the back of the leaf through the spaces between the parallel venations. In a few days the paleness turns distinctly yellow and then brown, resulting in complete withering of the leaf.

This was first noticed in the Sepaya farm, which is situated near the north-east corner of the district, in the year 1926. That year there was a high rise of sub-soil water level in August, following floods in the rivers, to within two feet of the surface. It is not known when exactly the canes got affected, but the yellowing was very bad in September and was fairly widespread over a tract extending from Sepaya to Siwan about 40 miles south and beyond. No systematic investigation was undertaken as the canes recovered by themselves soon after the October rains. No fungus was detected, there was some attack by insects on the canes, but it was never of any magnitude to justify the almost wholesale sickness of the crop in many fields.

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This sickness, or whatever it may be called, is seen only in the district of Saran affecting the cane Co. 213 first, and in its worst form it appears in the east of Gopalganj and Siwan Sub-divisions and partly in the Chapra Sub-division. Manuring, *viz.*, the addition of nitrogen and phosphoric acid and also of such salts as iron or manganese sulphate, has not been able to prevent it. This yellowing disease has never been seen in other North Bihar districts, *viz.*, Muzaffarpur, Darbhanga, North Bhagalpur or Purnea, and, so far as at present known, it is confined to the Saran district only and in one thana of the neighbouring district of Champaran on the other side of the Gandak.

The district of Saran has the shape of an isosceles triangle of which the equal sides are formed, one by the river Gandak and the other by the river Gogra and, after its confluence with the Ganges, by the Ganges. The country is a vast plain with a gentle slope from north to south. There are several small rivers in the district running the whole length north to south. The soil is a light loam and usually contains enough moisture throughout the year so as not to need irrigation. In the rainy season when the big rivers are in high flood there is a considerable rise of sub-soil water level in the tracts bordering on the rivers. In May and June this level stands at about 10 feet below the surface. After the breaking in of the monsoon there is a rapid rise of the water level which at Sepaya in the highest flood time reaches to within 2 ft. 6 ins. from the ground.

This high rise of sub soil water, in a year in which rainfall is deficient or in which a considerable break in the rains occurs, is often accompanied by a rise of soluble salts within the soil area covered by sugarcane roots. When this happens the delicate Co. 213 is the first to succumb, its growth stops, the leaves begin to get yellow and often a patch is formed in the field having sickly canes in the midst of healthy ones. Co. 210 is much more resistant to this drought and *usar* conditions, and Co. 205 is still more so, and they do not usually suffer. Though evaporation from the surface of the ground is reduced much on account of its being shaded by the thickly growing plants, the loss of moisture by transpiration and root-absorption is considerable and probably takes place at a more rapid rate than what can be replaced by the rise from below. In consequence, a greater concentration of salts in the root area takes place. The Co. 213 canes become thus more sickly and soon the top leaves die. If the drought continues, Co. 210 and even Co. 205 may suffer. A good shower of timely rain, however, checks the spread of the yellowing, and if the top shoots are not dead by then, the cane revives and continues to grow.

Even if the cane recovers and grows, it seldom attains proper maturity. The yellowing of leaves stops carbohydrate formation at the most important period of

its growth, and before the cane has regained its strength and balance the cold weather sets in, preventing further improvement. The sucrose content of the juice of such canes remains miserably low and was found in 1929 to be between 7 and 8 per cent. in January. Even when canes were not visibly affected, they do not attain the same juice-richness as one finds in the same variety in other parts of the province. The highest richness of Co. 213 juice in February-March is 13-14 per cent. of sucrose, while in South Bihar it goes up to 19 per cent. on the juice.

Similar remarks apply to the canes Co. 210 and Co. 205. No definite period of maturity is observed for either cane. For the greater part of January and February, the juice-richness remains low, fluctuating between 12 and 13 per cent. and seldom exceeds the latter figure. The climate as well as the soil with its moisture and soluble salts at the maturing time do not secure proper conditions for maturity. Though these canes do not always show the visible symptoms of the sickness by which Co. 213 is visited in the rainy season, their growth is nevertheless impeded by the conditions then obtaining and is probably not complete at the time when the cane ought to mature. In 1927 Co. 210 gave all the indications of a late maturing cane, and it was only in the middle of April that its juice reached 16 per cent. of sucrose.

This yellowing and its consequences occur almost every year in Sepaya and its immediate neighbourhood. Being only four miles off from the river Gandak, its sub-soil water-level is nearer the surface than of places further west. But the sickness does not always attract notice until it reaches alarming proportions. In 1929 Co. 213 was seriously affected over a wide area round Sepaya. The yellowing appeared in September soon after the floods in the river receded. A number of holes were dug round the good and the affected clumps to see if this was due to the sub-soil water reaching the root level and drowning the roots. In all cases the roots of the affected canes were on much drier ground and there was no indication of water-logging. On the other hand, canes standing on a low ground on which water actually collected were as healthy as before. Washing the roots of the sick canes with water improved the bad clumps and new shoots began to appear. A comparison was made, some time later, of the water-soluble salts in the soils of good and bad areas (Table A), and it was found that in the soil of the bad area lime had been replaced to a large extent by soda after the first six inches. In the good area there was a high proportion of $CaCO_3$, and sodium sulphate was entirely absent, and though sodium carbonate was fairly plentiful in the top surfaces, it was entirely absent below. In the bad area there were more salts and they consisted of the more harmful kinds than in the good area.

Such a result threw a new light on the investigations. It is not known how far the cane Co. 213 is tolerant of the salts. A periodic record of the amount and the character of the soluble salts present in the soil is now being kept from February 1930 when the canes were planted in the Sepaya farm. The tables appended (Tables I—X) give the salt concentrations at different depths.

In one of the worst lands (Plot 1B, N. W. corner—Table I) in February it will be seen that there was a large concentration of soda salts, consisting mainly of sodium sulphate in the first foot of the soil. The amount of carbonate of soda was low, as a large part of the carbon dioxide found might have been in combination with lime as bicarbonate. The chlorides were negligible in the surface up to six inches but existed in fair quantities below in the next foot. The high percentage of potash salts might be the result of an exchange due to the interaction of soda with the soil complex. The highest amount of salts was concentrated in the first two six inches, while from the twelvth inch downwards there was not very much change.

The saline accumulation near the surface was not large enough to prevent germination. But with the advance of the hot weather, as evaporation proceeded from the soil surface and more salts moved up increasing the concentration, the young cane plant sickened and died. In May wide gaps were noticed from where plants had been wiped out forming a barren space. The analytical figures will be found in Table II. The amount of salts increased at all depths. Both lime and soda increased correspondingly, and there was a large preponderance of the sulphates over the carbonates.

The surviving cane plants outside the area of this high concentration continued to grow well. But the soil salts were rapidly getting poorer in lime and richer in soda and the indications were that unless there was an immediate relief from this condition, the plants would not long remain in a flourishing state (Table III). In May and June there were 5·3 inches of rain and in July 12½ inches of which nearly 9 inches precipitated in one day. This resulted in a considerable lowering of the soluble salts in the soil (Table IIIA).

It was expected that the July rains washing down the harmful constituents and increasing the content of lime would result in an improvement of the condition of the canes. The one day's heavy rain in July in a field consolidated and made compact by the previous rains was not enough to compensate for the numerous small showers that usually fall throughout the month It was followed by hot and humid days with a warm sun. The sub-soil water lay 8 feet below the surface. The amount of soluble salts was low, much lower than what was found in either February and May on account of their being washed away by rain. But

still in a corner of the field the deep green leaves of Co. 213 canes were found to be turning yellow.

An examination of the salts present in the two portions of the same field, one containing green healthy plants and the other pale yellow ones, showed a considerable difference in the quantity and the composition of the soluble salts (Tables IV and V). Not only was the total quantity in the bad portion, except in the top six inches, everywhere higher than in the good portion, but there was also a large diminution in the amount of lime salts and a consequent increase of soda salts in the bad area. There were indications, however, that both the good and bad soil layers below 18 inches were rapidly becoming similar in concentration and composition. It would therefore appear that the difference in the condition of the cane in the two fields was due at this stage of growth to the soil conditions in the layers between the 12th and 18th inches below the surface. It was here that the cane roots of the second and the third order were congregated. The actual quantity of the total salts or even of soda in this layer was not as high as in the bad fields in May in which canes were then growing. The growth was not disturbed in June. The appearance of wilting in July suggested that the rapidly growing Co. 213 with its broad foliage was giving out more water than it was receiving through the roots. On examination it was found that the epidermal layers of the sucking root hairs were injured or damaged, probably due to long contact with saline soil solutions. This injury or damage might have made them inactive or unable to function properly so as to meet the heavy demand of water now made by the growing crop.

In good fields the situation was different. In a better drained and more easily workable adjoining field in which no yellowing of the canes was visible, the salt concentrations were apparently not the same. There was no rise in May over the February concentration. Lime increased, and the harmful alkalis which diminished were brought down so low that it could be just conceived that the plants had made use of and consumed them at a rate which outbalanced the rise from below. But though the total salts diminished in July and August, the proportion of the various salts did not show a large change. Such an even condition of the field produced uniform and healthy canes (Tables I and II).

In August there were 6 68 ins. of rain in Sepaya, mostly light showers, of which one inch fell on three days, *viz.*, the 1st, 12th and 18th. The affected canes did not improve, although salt concentrations had gone down further and accumulated below two feet. The sub-soil water level was fluctuating between 7½ ft. in the beginning of the month and 6 ft. towards the end. There was no rain in the early part of September and the sub-soil water tended to move downwards. Thus a

condition akin to drought was established. The top soils were drying and the cane plants depended for their nourishment on the lower layers of the soil where the salts had now concentrated. In the Siwan sub-division where rainfall was much more scanty throughout the season, being 1½ ins. in June, 10 ins. in July and 2·8 ins. in August (as against 6·9 ins. in June, 12·5 ins. in July and 12·4 ins. in August in 1929), the land must have been much too dry for the Co. 213 to thrive. The minimum water-requirement of the cane varieties is not known, but it must be much greater for the broad-leafed Co. 213 than the narrower-leafed Co. 210 and Co. 205. This must be the reason why when in the Siwan area Co. 213 was yellowing all over, the land, except here and there, was not dry enough for Co. 210. The canes here had not much to contend against the *usar* conditions of the soil as in Sepaya or its neighbourhood, and therefore stood much longer on the field in good condition until they began to feel the drought. Irrigation improved the condition considerably, and a cultivator of Puraina, a village about 5 miles north of Siwan, stated with satisfaction that a day's watering made the irrigated lines of canes greener and taller than the un-irrigated ones.

It is not the actual amount of salts in the soil, but the strength of the solution in soil water that matters in arresting the growth of the plants. Consequently although the amount of the salts in some of the plots may appear to be much the same, the amount of the water held by the soil particles, if different, would make a considerable difference in the solution, and the drier the soil is, the greater being the strength of the solution, the more danger there is to the plant. In Table IX, the figures for two fields are given. In the first the Co. 210 canes were healthy, and in the other they were decidedly weak and becoming pale. The moisture content appeared to be different, and it was the lower moisture which was the factor that decided for yellowing, no appreciable difference being perceptible in the figures for salts. Similarly with Co. 213. Outside the farm there was particularly a good Co. 213 plot. The soluble salts in August apparently presented no great difference to that in a farm plot in which canes had badly yellowed. But the former being by the side of a small stream which was then full and whose water level was higher than the land, was kept in a wet condition, while the farm land was comparatively dry (Table X).

It must be noted with satisfaction that Co. 210 under these conditions did everywhere better than Co. 213. It yellowed in Sepaya where the salts had come in, but much later than Co. 213, and was never as bad as Co. 213. It resisted drought much better than Co. 213. In the Siwan area it was not unusual to find Co. 210 and Co. 213 growing side by side, the one a pleasantly green crop and the other sickly-looking and stunted. The Siwan cultivators are showing a preference

for this cane to Co. 213, and there is now no Co. 213 in the south and west of Siwan in the cultivators' lands.

An idea of the resistance of Co. 205 to the *usar* conditions prevailing in Sepaya can be had from Tables VI to VIII. Though not particularly as bad as that in which canes were wiped out in May, the field was worse as regards surface concentration of salts than any other examined. There was no yellowing in July, but towards the end of August when droughty conditions prevailed it showed signs of yellowing. It is the most tolerant of the canes to the Sepaya conditions and is preferred to Co. 213 in the neighbouring *diara* lands.

But Co. 205 is a hard cane with a large amount of fibre. Its sugar content is not high, though at Sepaya it often produces as much sugar as Co. 213 or more. It is also attacked with mosaic disease. Though mosaic has not yet affected the tonnage or sugar content of the yield, as it is inherited there is the probability of the progeny being seriously affected in some generations. In spite of these defects its resistance to yellow sickness maintains its popularity. Co. 210 has also been noted as very susceptible to fungus diseases. In 1929 at Sepaya it yielded juice of very low sugar content and was in this respect behind both Co. 205 and Co. 213. Co. 213, as described above, is very much susceptible to adverse soil conditions and cannot always be depended upon to produce satisfactory tonnage or rich juice. Moreover the plants so weakened fall easy victims to insect attack.

Though the right cane has not yet been found to suit the district of Saran for all weather, yet Co. 213 is easily the heaviest yielding and also the sweetest of all the canes so far tried in this district. But it has a precarious existence, as rainfall in time and amount cannot always be depended upon to produce favourable conditions for prosperous growth. It is not unlikely that conditions may arise, if not every year, once in two or three years when this variety may be very seriously affected over wide areas. Unless therefore irrigation becomes a habit of the cultivator to supplement the defect in rainfall, it is not safe to recommend its introduction into the district. From the results of examination of the soluble salts in Sepaya, it appears that a deficiency of lime and the consequent increase of soda salts produce a physiological unbalance in the cane resulting in sickness. A supply of lime in July seems therefore to be an obvious remedy, and the result of an application of calcium cyanamide instead of ammonium sulphate may be awaited with interest. In the meantime the extended introduction of Co. 213, in lands where facilities for irrigation do not exist or where the land is so poor that the cost of irrigation cannot be set off against the increased yield of the cane, should be proceeded with caution.

The above discussion of the conditions is based on the results of one year's study only. The investigation is, however, being continued.

TABLE A.

*Sugarcane good.*

| Inches below the surface | 0—6 | 6—12 | 12—14 | 14—18 | Lower |
|---|---|---|---|---|---|
| Calcium carbonate | 68·5 | 63·6 | 69·3 | 67 0 | 62·0 |
| Sodium sulphate | Traces | 7·2 | Traces | Traces | Traces |
| Sodium carbonate | 15·6 | 15·7 | ,, | ,, | 2·5 |
| Potash salts | 9·2 | 10·7 | 9·8 | 11·7 | 10·8 |

*Sugarcane bad.*

| Inches below the surface | 0—7 | 7—14 | 14—17 | Lower |
|---|---|---|---|---|
| Calcium carbonate | 43 4 | 32·1 | 31·3 | 31 3 |
| Sodium sulphate | 9·0 | 27 0 | 30·0 | 29·5 |
| Sodium carbonate | 38·7 | 30 0 | 35·0 | Traces |
| Potash salts | 2·5 | 1·8 | 2·4 | 1·8 |

TABLE I.

*Sepaya, IA (Good land), February 1930.*

| Inches below the surface | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Water-soluble salts | 0·107 | 0·096 | 0 110 | 0 096 | 0·078 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | 4·67 | 3·12 | 5·43 | 14·58 | 9·61 |
| CaO | 28·02 | 32·30 | 20·45 | 15 62 | 16·03 |
| MgO | 9·25 | 6·76 | 7·71 | 5·21 | 11·53 |
| $Na_2O$ | 15·50 | 11·05 | 19·04 | 23 53 | 28·38 |
| $K_2O$ | 9·26 | 5·54 | 5·12 | 7·24 | 7·23 |
| $SO_3$ | Traces | Traces | Traces | Traces | Traces |
| $CO_2$ | 39·73 | 44·23 | 51·80 | 34 40 | 30·40 |

TABLE 1—*contd.*

*The same land in May 1930.*

| Inches below the surface | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Water-soluble salts | 0·0860 | 0·0450 | 0·0850 | 0·0610 | 0·0582 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | Traces | Traces | Traces | Traces | Traces |
| CaO | 49·43 | 52·22 | 47·60 | 40·98 | 32·00 |
| MgO | .. | .. | .. | .. | ... |
| $Na_2O$ | 12·70 | .. | 6·02 | 1·00 | 11·43 |
| $K_2O$ | 1·40 | .. | 0·90 | .. | 0·65 |
| $SO_3$ | Traces | Traces | Traces | Traces | Traces |
| Cl | 7·12 | 8·44 | 9·02 | 18·70 | 23·00 |
| $CO_2$ | 33·14 | 40·32 | 36·47 | 39·32 | 33·3 |

*Sepaya, IB (N. W. Corner), Co. 213, February 1930.*

| | | | | | |
|---|---|---|---|---|---|
| Water-soluble salts | 0·2906 | 0·2274 | 0·185 | 0·1850 | 0·1672 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | 4·50 | 7·48 | 15·41 | 17·26 | 20·92 |
| CaO | 9·50 | 8·58 | 13·51 | 12·16 | 17·91 |
| MgO | 2·03 | *Nil* | 1·47 | 1·17 | 2·93 |
| $Na_2O$ | 23·85 | 19·25 | 12·45 | 12·63 | 6·27 |
| $K_2O$ | 19·45 | 10·02 | 12·82 | 12·92 | 5·18 |
| $SO_3$ | 23·50 | 20·93 | 13·75 | 22·04 | 14·24 |
| $CO_2$ | 15·50 | 13·20 | 16·20 | 13·00 | 18·00 |
| Cl | 2·25 | 20·54 | 14·39 | 8·82 | 14·55 |

TABLE II.

*Sepaya, 1A (Good land), July 1930.*

| Inches below the surface | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Water-soluble salts | 0·0684 | 0 0708 | 0·0716 | 0 0776 | 0·1446 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | Traces | Traces | Traces | Traces | Traces |
| CaO | 45 86 | 35·50 | 21·04 | 14 44 | 10 50 |
| MgO | Traces | Traces | Traces | 2·60 | 2·80 |
| $Na_2O$ | 16·46 | 17 88 | 13·02 | 36·69 | 37·52 |
| $K_2O$ | 6·46 | 2·98 | Traces | Traces | 0·84 |
| $SO_3$ | 2·51 | 3·55 | 6·86 | 5·85 | 4·30 |
| $CO_2$ | 29 69 | 27 82 | 33 60 | 32 25 | 18 90 |
| Cl | 6·61 | 6·30 | 10·50 | 5·80 | 5·2[illegible] |

*Sepaya, IB (N. W. Corner), Co. 213, May 1930.*

| | | | | | |
|---|---|---|---|---|---|
| Water-soluble salts | 0·5246 | 0·4536 | 0·2360 | 0·3616 | 0·2408 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | Traces | Traces | Traces | Traces | Traces |
| CaO | 15·52 | 7·6 | 12·06 | 5·73 | 14·60 |
| MgO | 2 72 | 1 9 | 2·23 | 2·04 | 1·20 |
| $Na_2O$ | 32·56 | 30·4 | 37·43 | 23·62 | 23·04 |
| $K_2O$ | 19·32 | 20 9 | 23·60 | 25·37 | 25·61 |
| $SO_3$ | 35·32 | 16·5 | 20·30 | 20·72 | 25·50 |
| Cl | 13·39 | 13·8 | 20·90 | 13·33 | 11 85 |
| $CO_2$ | 7·20 | 9·01 | 10·80 | 10·02 | 10·62 |

TABLE III.

*Sepaya, IB (S. E. corner), Co. 213, May 1930.*

| Inches below the surface | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Water-soluble salts | 0·1386 | 0·2120 | 0·3130 | 0 1430 | 0·1730 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | Traces | Traces | Traces | Traces | Traces |
| CaO | 29·00 | 9 81 | 8 00 | 12·25 | 21·01 |
| MgO | 0 76 | 10 18 | 3·43 | 2·57 | 3·81 |
| $Na_2O$ | 18·09 | 26·05 | 29·81 | 21 00 | 24·19 |
| $K_2O$ | 9·12 | 7·56 | 10 56 | 5·63 | 7·93 |
| $SO_3$ | 10·00 | 34·50 | 34 37 | 43·72 | 23·64 |
| Cl | 6·95 | .. | 4 23 | 6·64 | 4·38 |
| $CO_2$ | 26 83 | 14·13 | 10·54 | 11·52 | 8·98 |

TABLE III-A.

*The same land in August 1930.*

| | | | | | |
|---|---|---|---|---|---|
| Water-soluble salts | 0·0610 | 0·0802 | 0·0772 | 0·0880 | 0·1080 |
| $Fe_2O_3$ | 10·49 | 12·00 | 10·40 | 3·61 | .. |
| CaO | 19·68 | 14·00 | 20·80 | 16·35 | 19·26 |
| MgO | 5·70 | 2·17 | 2·26 | 7 49 | 7·22 |
| $Na_2O$ | 33·02 | 42·37 | 35·75 | 41·80 | 23.98 |
| $K_2O$ | 9·62 | 5·50 | 5·33 | 4 65 | 6·29 |
| $SO_3$ | 7·02 | 5·87 | 13·19 | 18·63 | 15·83 |
| Cl | 6·15 | 3·75 | 5·85 | 2·61 | 3·42 |
| $CO_2$ | 26·11 | 22·00 | 21·20 | 12·72 | 23·15 |

TABLE IV.

*Sepaya, IA (Yellowing begun), Co. 213, July 1930.*

| Inches below the urface | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Water-soluble salts | 0·0600 | 0·1174 | 0·1642 | 0 1222 | 0·0666 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | 2·65 | Traces | 1·46 | 0 65 | 3·60 |
| CaO | 29·21 | 21·76 | 6·34 | 7·21 | 6·04 |
| MgO | 2·88 | 2·21 | 2·29 | 3·09 | 4 78 |
| $Na_2O$ | 20·08 | 27·20 | 40·32 | 36·49 | 32·01 |
| $K_2O$ | 7·96 | 2·29 | 1·62 | 3·19 | Traces |
| $SO_3$ | 5·64 | 17·08 | 19·58 | 15·66 | 14·54 |
| $CO_2$ | 31·54 | 17·00 | 17·80 | 28·04 | 28·50 |
| Cl | 5·04 | 11·47 | 14·40 | 4·92 | 6·75 |

TABLE V.

*Sepaya, IA (crop still good), Co. 213, July 1930.*

| Inches below the surface | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Water-soluble salt | 0 0684 | 0·0708 | 0·0716 | 0·0776 | 0 01446 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | Traces | Traces | Traces | Traces | Traces |
| CaO | 45·86 | 35·50 | 29·04 | 14·44 | 10·50 |
| MgO | Traces | Traces | Traces | Traces | Traces |
| $Na_2O$ | 16·46 | 19·88 | 13·02 | 36·49 | 37·52 |
| $K_2O$ | 6·46 | 2·98 | Traces | Traces | 0·84 |
| $SO_3$ | 2·51 | 3·55 | 6·86 | 5·85 | 20·30 |
| $CO_2$ | 29·69 | 29·82 | 33·60 | 32 25 | 18·90 |
| Cl | 6·61 | 6·30 | 10·50 | 5·80 | 5·25 |

TABLE VI.

*Sepaya, IB (Triangular land), Co. 205, February 1930.*

| Inches below the surface. | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Water-soluble salts | 0 2310 | 0·114 | 0·0976 | 0·085 | 0·069 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | Traces | 5·04 | 6·71 | Traces | Traces |
| CaO | 4·96 | 9·24 | 14·23 | 19·42 | 26·09 |
| MgO | 2·60 | 1·56 | 0·75 | 5·30 | 6 53 |
| $Na_2O$ | 41·86 | 37·54 | 40·62 | 40·36 | 37·50 |
| $K_2O$ | 5·40 | 0 88 | 1·25 | 1 10 | 2·04 |
| $SO_3$ | 32 72 | 31·45 | 33·00 | 24·00 | 26 40 |
| $CO_2$ | 13·03 | 15·20 | 12 90 | 11·70 | 14·70 |

TABLE VII.

*Sepaya, Same land, Co. 205, July 1930.*

| Inches below the surface. | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Water-soluble salts | 0 1300 | 0·1622 | 0·0938 | 0·0814 | 0·0892 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | 16·63 | 9 87 | 17·80 | 7.87 | 5 88 |
| CaO | 8·00 | 4 24 | 3 44 | 2·00 | 5·37 |
| MgO | Traces | Traces | Traces | Traces | Traces |
| $Na_2O$ | 38 09 | 47·07 | 29·15 | 41 08 | 37·77 |
| $K_2O$ | 6·62 | 1·23 | 8·05 | 2 46 | 1·36 |
| $SO_3$ | 14·78 | 26·10 | 24·38 | 14 39 | 12·20 |
| Cl | 3·46 | 3·70 | 4·77 | 5·53 | 4·14 |
| $CO_2$ | 22·10 | 14·79 | 22·04 | 27·55 | 23·29 |

## TABLE VIII.

*Sepaya, Triangular Plot, Co. 205, August 1930.*

| Inches below the surface. | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Nitrogen | 0 078 | 0 074 | ... | | . |
| Water-soluble salts | 0·1660 | 0·1770 | 0·0790 | 0·0740 | 0 0784 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | 3·36 | 0·89 | 5 04 | 2 17 | 0 14 |
| CaO | 8 64 | 7·61 | 17·13 | 21 70 | 12 04 |
| MgO | Traces | Traces | Traces | Traces | Traces |
| $Na_2O$ | 39 54 | 37·74 | 29·86 | 30 24 | 39 29 |
| $K_2O$ | 0 72 | 2·29 | 2·64 | 1 62 | 0·96 |
| $SO_3$ | 27·30 | 23·80 | 12 85 | 8 10 | 10 88 |
| Cl | 4·86 | 1·68 | 3·28 | 4·99 | 3 84 |
| $CO_2$ | 14·40 | 23 44 | 28 22 | 35 10 | 28·16 |

## TABLE IX.

*Sepaya, Sample I (1A, Co. 210, Healthy), August 1930.*

| Inches below the surface. | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Nitrogen | 0·062 | 0·084 | ... | ... | .. |
| Water-soluble salts | 0·0920 | 0 1420 | 0·1880 | 0·1500 | 0·1400 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | 23 54 | 9 52 | 6 57 | 8 44 | 14·20 |
| CaO | 17 09 | 24·46 | 25·52 | 16·63 | 6·36 |
| MgO | 1·58 | 2·03 | .. | 1 51 | 1·42 |
| $Na_2O$ | 28·34 | 28 14 | 35·51 | 46·13 | 50·83 |
| $K_2O$ | 5·77 | 2 94 | 2·22 | 2·64 | 2·73 |
| $SO_3$ | 1·85 | 4·48 | 15·37 | 19·99 | 10 43 |
| Cl | 3·27 | 3·15 | 1·59 | 1·98 | 1·06 |
| $CO_2$ | 19·50 | 21·28 | 15·90 | 19·14 | 20·12 |

TABLE IX—*contd.*

*Sepaya, Sample II (Co. 210 just beginning to be yellowed), August 1930.*

| Inches below the surface. | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Nitrogen | 0 082 | 0 080 | .. | .. | .. |
| Water-soluble salts | 0·0790 | 0 1340 | 0 1760 | 0 1480 | 0 0922 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | 0·30 | 2·22 | 2·80 | 7·37 | 7·84 |
| CaO | 19·75 | 30·36 | 27·44 | 18·31 | 7·33 |
| MgO | Traces | Traces | Traces | Traces | Traces |
| $Na_2O$ | 18·64 | 32·26 | 33 78 | 46 23 | 41·42 |
| $K_2O$ | 6·67 | 0 88 | 5·33 | 1·27 | 2·40 |
| $SO_3$ | 3·15 | 2·22 | 13 68 | 22·78 | 16 35 |
| Cl | 20·79 | 1·11 | 2·56 | 2·68 | 3·27 |
| $CO_2$ | 31·50 | 23 68 | 14·25 | 16·08 | 24·41 |

TABLE X.

*Sepaya (Outside the Farm), Co. 213 healthy, August 1930.*

| Inches below the surface. | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Water-soluble salts | 0·0804 | 0·0820 | 0·0874 | 0 0870 | 0 0766 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | .. | 1·95 | .. | 3 68 | 16 76 |
| CaO | 40 00 | 18·54 | 29·44 | 19 32 | 26·22 |
| MgO | .. | ... | .. | ... | ... |
| $Na_2O$ | 28·00 | 31·11 | 31·39 | 40 36 | 28·00 |
| $K_2O$ | 5·50 | 1·46 | 0·87 | 3 91 | 3·53 |
| $SO_3$ | 1·60 | 2·07 | 1·72 | 3·68 | 3·91 |
| Cl | 1·87 | 8·17 | 4·25 | 3·45 | 2 16 |
| $CO_2$ | 33·00 | 33·18 | 23·00 | 25·76 | 21·44 |

TABLE X—*contd.*

*Sepaya, 1A, Co. 213, August 1930.*

| Inches below the surface. | 0—6 | 6—12 | 12—18 | 18—24 | 24—30 |
|---|---|---|---|---|---|
| Nitrogen | 0·068 | 0·078 | .. | .. | .. |
| Water-soluble salts | 0·0604 | 0·0744 | 0·0576 | 0·0554 | 0·0630 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | Traces | 8·03 | Traces | Traces | Traces |
| CaO | 25·84 | 21·60 | 25·20 | 28·96 | 37·60 |
| MgO | Traces | Traces | Traces | Traces | Traces |
| $Na_2O$ | 18·16 | 15·66 | 21·00 | 20·16 | 24·00 |
| $K_2O$ | 7·65 | 4·32 | 3·15 | 5·18 | 2·88 |
| $SO_3$ | 5·10 | 6·06 | 5·25 | 5·40 | 0·56 |
| Cl | 5·10 | 8·10 | 5·25 | 5·40 | 3·60 |
| $CO_2$ | 28·20 | 31·60 | 38·00 | 40·32 | 35·84 |

# ELECTRICITY AND FARMING.*

BY

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It is not the intention of this paper to discuss electricity in all its numerous aspects as a possible factor in the future of Indian farming. That would be too ambitious an undertaking. One aspect of electrical energy, namely, its use as a stimulator of plant life and soil activity was dealt with by Dr. Nehru in a paper read at the Indian Science Congress last year. The present paper deals with an entirely different function of electrical energy. namely, the power which can be harnessed for use with machinery on the farm.

The subject of rural electrification is receiving much attention in the world these days. Indeed the subject was discussed as recently as last June at the second Plenary World Power Conference at Berlin. The following two instances, one outside and one within the British Empire, indicate the importance of the subject in present day rural economics :—

(1) In the United States of America, 7 per cent. of the farms are supplied with electrical energy for light or for power and 400,000 individual farm light-power plants are in operation. The remainder acquire their electrical energy either from small energy power plants or from the transmission lines of large electrical stations.

(2) New Zealand with a population of one and a half millions is agriculturally progressive largely because of the utilization of electrical energy. Dairy farms which until recent years were equipped with oil-engines driving milking plants, etc., have now scrapped these engines through co-operation of farmers and Power Boards and have substituted electricity as the motive power. This power is now used for water pumping, sheep shearing, dairy and domestic purposes.

Turning to India, there are in existence a number of hydro-electric schemes for rural electrification, but the progress compared with the countries mentioned above is slow. In the United Provinces the Ganges Canal Hydro-electric Scheme is nearly complete. It extends into seven districts containing 60 towns and large villages

* Paper read at the Indian Science Congress, Agricultural Section, Nagpur, January 1931,

having a population of 5,000 and over. The rates at which power will be available at an early date are :—

(1) for domestic purposes 5 as. 6 pies per unit,

(2) for minor industries 1 a. 6 pies per unit,

(3) for agricultural purposes one anna per unit.

So great is the demand for electrical energy in this area that a net revenue of Rs. 4·2 lakhs has been guaranteed, the outlay on the entire scheme being Rs. 106 lakhs.

The question arises as to what purposes apart from domestic use this energy will be put. The tract through which the mains and branch lines pass consists for the most part of zemindaris held by petty zemindars. There are also a large number of rich landlords. It is too early yet to foretell the extent to which this electrical power will be utilized by tenants, but it is certain that the main use to which the zemindars will put the electrical power is the pumping of water to tap "the great underground reservoirs which underlie the whole of the tract in question at a depth of from 20 to 30 ft." When cheap power is available and it is not used for pumping water every day in the year, it is natural that the agriculturist should think of harnessing it for other purposes. In the above tract consisting of the districts of Saharanpur, Muzaffarnagar, Meerut, Bulandshahr, Aligarh, Bijnor and Moradabad, the purposes for which the agriculturist is likely to utilize this available electrical energy are one or more of the following :—

Cane crushing, driving sugar centrifugals, fodder cutting, threshing, bone crushing, saw milling, flour milling, workshop and dairy purposes and perhaps tackle ploughing.

This is quite apart from the main purpose to pump up water and domestic use.

Very little experience is available to place before the agriculturist figures on the comparative economics of the different forms of available power such as oil-engines, steam-engines and electricity. Investigations of this nature are being carried out on the Government Agricultural College Farm at Cawnpore with reference to water pumping, threshing and fodder cutting. Figures are at present available, however, regarding the latter two only. On this farm, where both intensive and extensive cultivation are practised, electrical power is available through an extension of the town supply at the rate of 2 as. 6 pies per unit for the first 900 units consumed each month and thereafter at half that rate. It will be observed that this rate for all practical purposes is two and a half times as high as that which is contemplated in the hydro-electric scheme referred to above.

The following statement gives the comparative cost per maund of clean wheat grain obtained by threshing on the above farm with a 22×38 McCormic Deering Rice Thresher :—

STATEMENT I.

*Comparative cost of threshing wheat.*

| | 1929 Outturn of 15·6 mds. of clean grain per hour | 1930 Outturn of 8·6 mds. of clean grain per hour |
|---|---|---|
| Power used — | | |
| Petrol paraffin engine 15-30 H. P. . | Cost of threshing per maund 5·2 as. | Cost of threshing per maund 13 8 as |
| Electricity 25 H. P. motor, 3 phase 50 cycle. A. C. 400 volt | Cost of threshing per maund 3 7 as. | Cost of threshing per maund 6·8 as. |

It should be noted that in these experiments the 1929 results with the threshing machine were nearly twice as good as those obtained in 1930. The reason for this was that in the latter year the proportion of straw to grain was a good deal higher than usual, and the straw was inclined to be leathery, thus greatly impeding the progress of threshing in the concave of the machine. Further particulars of Statement I are given in Appendix I. The result indicates that electricity on the farm for threshing purposes is considerably cheaper than the petrol paraffin engine, even though the cost of electricity was 2 as. 6 pies per unit. The following statement gives the comparative cost of threshing by petrol paraffin engine against electricity taking the cost of current at one anna per unit. In this case with an outturn of 15·6 mds. per hour the cost by electricity is about half that by petrol paraffin engine.

STATEMENT II.

| | 1929 Outturn 15·6 mds. per hour | 1930 Outturn 8·6 mds. per hour |
|---|---|---|
| Petrol paraffin engine. . . . . . . | 5·2 as. per md. | 13·8 as. per md. |
| Electric motor . . . . . . . | 2·9 as. „ „ | 5·0 as. „ „ |

It is instructive to note that in 1929 with the same crop of wheat threshed by the country method the cost per maund of grain obtained came to Rs. 1-0-1½ pies, or more than five times the cost by electricity.

Turning to the cost of chopping green fodder, a practice which is economical and advisable on every modern farm both for purposes of making silage and for feeding cattle, the following statement gives the comparative cost when the power used is (1) electricity, (2) an internal combustion petrol paraffin engine, (3) a hand worked fodder-chopping machine, and (4) the country method with a chopper.

STATEMENT III.

*Comparative cost of chopping green jwar* (Sorghum vulgare) *fodder.*

Working at 8 hours a day.

| | Cost per maund ¾″ cut. |
|---|---|
| By electric motor at 1 anna per unit | 2·9 pies |
| „ at 2·5 annas per unit | 4·1 „ |
| By a petrol paraffin engine | 4·3 „ |
| By hand power machine | 5·7 „ |
| By country method with a chopper | 15·0 „ |

Full particulars are given in Appendix II.

From the above statement the value of electricity at one anna per unit for purposes of chopping fodder is quite evident. The cost of this operation by a petrol paraffin engine is again nearly double that by electricity. On a large farm where many cattle have to be maintained and particularly on dairy farms, a fodder-chopping machine run by electricity adds greatly to the efficiency of the farm and makes the consumption of bulky fodder by cattle economical. Where the making of silage is required, the advantage of producing chopped fodder at 2·9 pies per maund (about ⅕th the cost of the indigenous method) is considerable. The work is done both quickly and cleanly. The outturn from the machine, which in this case is a small McCormick Deering F Type ensilage cutter, is, for a ¾″ cut, about 75 maunds per hour. This quantity, *i.e.*, one hour's work, would be sufficient for the daily requirements of about 100 head of dairy cattle of all classes.

The motor would thus be employed for chopping fodder for about an hour a day on a dairy farm with 00 head of cattle. It would then be available for the rest of the day for such work as feed grinding, pumping water, domestic purposes, saw millng, flour milling, workshop, sugar machinery and the like.

Although the above observations cover a limited field for the utilization of electrical energy, they indicate possibilities which are well worth careful study by people interested in modern farming methods in such parts of the country as are likely to provide cheap electrical power for the use of the agriculturist.

# APPENDIX I.

## DETAILS OF COST OF THRESHING A MAUND OF CLEAN WHEAT.

### (a) *By petrol paraffin engine (McCormic Deering 15-30 tractor), 1929 results with outturn of 15·6 mds. of grain per hour.*

| | Rs. | A. | P. |
|---|---|---|---|
| Interest on capital (thresher) at 6 per cent. | 270 | 0 | 0 |
| Interest on engine (tractor) at 6 per cent. | 270 | 0 | 0 |
| Depreciation on thresher at 10 per cent. | 450 | 0 | 0 |
| Depreciation on tractor at 10 per cent. | 450 | 0 | 0 |
| Repairs and renewals on thresher | 300 | 0 | 0 |
| Repairs and renewals on tractor | 200 | 0 | 0 |
| Fuel 792 gallons of kerosine oil at As. 12-6 per gallon | 627 | 0 | 0 |
| Petrol at 3 pints per day for 42 days' actual running at As. 3 per unit | 23 | 10 | 0 |
| Lubricating oil 1·66 gallons per day of 10 hours at Rs. 1·03 per gallon | 71 | 12 | 9 |
| Grease 1·3 lbs. per day at 2·6 lbs. per rupee | 21 | 0 | 0 |
| Labour and staff | 315 | 0 | 0 |
| Miscellaneous | 30 | 0 | 0 |
| Total cost for 60 days | 3,028 | 6 | 9 |

∴ Cost per day = Rs. 50-7-7
and for 156 mds. = 5·2 annas per maund.

### (b) *By electricity using the same thresher as above.*

| | Rs. | A. | P. |
|---|---|---|---|
| Cost of running thresher including labour (taken from the above statement) | 22 | 12 | 0 |
| Daily consumption of 80 units of current per day at 2·5 annas a unit | 12 | 8 | 0 |
| Rent of motor | 1 | 2 | 6 |
| Total | 36 | 6 | 6 |

∴ With outturn of 156 mds. per day the cost per maund of grain

$$\text{threshed} = \frac{\text{Rs. } 36\text{-}6\text{-}6}{156} = 3{\cdot}7 \text{ annas.}$$

Taking the outturn of 1930 experiments, namely, 8·6 mds. per hour, the above costs are increased as follows: —

| | |
|---|---|
| By petrol paraffin engine | 13·8 annas per md. |
| By electricity at 2·5 annas per unit | 6·8 annas per md. |

The above worked out when electricity is selling at 1 anna per unit comes to—

| | |
|---|---|
| 1929 results | 2·9 annas per md. |
| 1930 results | 5·0 annas per md. |

## APPENDIX II.

### (a) *Cost of chopping fodder with a McCormic Deering F Type ensilage cutter by kerosine oil engine and electricity.*

Size of cut ¾ inch.
Outturn of machine 600 mds. in a working day of 8 hours.

| | |
|---|---|
| Cost of machine | Rs. 750. |
| Cost of driving equipment | Rs. 200. |
| | Rs. 950. |

#### (i) *Kerosine oil engine.*

| | Daily cost Rs. | A. | P. |
|---|---|---|---|
| Depreciation, taking 500 working days as life of the machine, per day of 8 hours $= \frac{750}{500}$ | 1 | 8 | 0 |
| Interest at 6 per cent. per annum taking 100 working days in a year | 0 | 9 | 1 |
| Depreciation on driving equipment at 10 per cent of capital cost on 200 working days in the year of which 100 are for this work | 0 | 1 | 7 |
| Labour, *i.e.*, 4 feeders at 5 annas and part debit of machanics' charges | 2 | 0 | 0 |
| Repairs at Rs 100 per annum, taking 100 working days in a year | 1 | 0 | 0 |
| Lubricating oil and sundries | 0 | 2 | 0 |
| | 5 | 4 | 8 |
| Engine charges for an 8 B. H. P. oil engine for an 8 hour day at Re. 1 per B. H. P. hour | 8 | 0 | 0 |
| Total cost per day | 13 | 4 | 8 |

$\therefore$ Cost per md. of fodder chopped $= \frac{\text{Rs. } 13\text{-}4\text{-}8}{600} = 4{\cdot}3$ pies.

#### (ii) *Electricity.*

| | Rs. | A. | P. |
|---|---|---|---|
| General expenses on machine as above | 5 | 4 | 8 |
| Rent of electric motor 25 H. P. | 1 | 2 | 6 |
| Cost of 40 units consumed in 8 hours at 2·5 annas per unit | 6 | 4 | 0 |
| Total | 12 | 11 | 2 |

$\therefore$ Cost per maund of fodder chopped $= \frac{\text{Rs. } 12\text{-}11\text{-}2}{600} = 4{\cdot}1$ pies.

Worked out at 1 anna per unit the cost per maund comes to 2 9 pies.

(b) *Cost of chopping fodder by hand worked ensilage cutter (Richmond and Chandler).*

**Price of machine Rs. 100.**
**Outturn per hour 6 mds.**
**Size of cut ½ inch.**

| | Cost per day Rs. | A. | P. |
|---|---|---|---|
| Depreciation on 500 working days as life of machine . . . . . | 0 | 3 | 3 |
| Repairs and interest at Rs. 15 per year at 200 working days in a year . | 0 | 1 | 0 |
| Three labourers at 6 annas per day . . . . . . . . | 1 | 2 | 0 |
| | 1 | 6 | 3 |

**Outturn in 8 hours day = 48 mds.**

**∴ Cost per md. of fodder chopped = 5·7 pies.**

(c) *Cost of chopping fooder by country method with a chopper*

(Experiment conducted on 8th September 1930. One man chopped 30 seers of fodder in one hour.)

| | Cost per day Rs. | A. | P. |
|---|---|---|---|
| One labourer on 6 annas per day . . . . . . . . | 0 | 6 | 0 |
| Depreciation, interest and repairs of implement . . . . . . | 0 | 0 | 3 |
| | 0 | 6 | 3 |

Outturn per day of 8 hours allowing for rest for labourer = 5 mds. of ½ inch cut.

∴ Cost per maund = 15 pies.

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# ABSTRACTS.

## A New Bunt on Wheat in India*. M. Mitra. *Annals of Applied Biology.* *(In the Press.)*

Specimens of diseased seeds of eight hybrid wheats were collected at Karnal, Punjab. These wheats were from crosses between Federation and Pusa 4 and 52 respectively, and had been bred in the Botanical Section at Pusa and sent to Karnal for trial under Punjab conditions. Examination showed the presence of a species of *Tilletia* which appeared to differ from any *Tilletia* previously described on wheat. This diagnosis was confirmed at the Imperial Bureau of Mycology and the name *Tilletia indica* n. sp. has been proposed for the new fungus. Some of these hybrid wheats were grown in Pusa, but so far no disease appeared under Pusa climatic conditions. A technical description of this hitherto undescribed species is given, showing the parts in which it differs from the two known species of *Tilletia* previously recorded on wheat. [M. M.]

## Studies in Indian Barleys. (1) Classification of Types isolated at Pusa Rakhal Das Bose. *Ind. J. Agric. Sci*, 1, 58.

This paper describes the cultivation, use and history of barley in India, and deals in detail with the morphological and agricultural characters of the crop. The morphological characters which are of importance in the classification of types are eight in number. The degree of fertility, which depends upon the nature of the lateral spikelets, is of the first importance and is closely followed by the character of the hull and the nature of the terminal appendages of the lemma. Colour of the spikelet and leaf-sheath, density, *i. e*, number of spikelets per unit length of rachis are all of importance in the classification of the crop

Agricultural characters are characters which are of the first importance in the economic value of the crop but possess less use as taxonomic criteria than the morphological characters described above. Among agricultural characters the nature of the root-system, whether deep or superficial, is the most important, determining as it does the type of soil in which the crop can be successfully cultivated. Tillering capacity, time of maturity, lodging and bushel weight are all agricultural characters which must be considered in estimating the value of a type Nitrogen content is also of importance in the case of malting barleys, while in Bihar the capacity to resist *Helminthosporium* disease is an important property.

The author describes 24 types of barley among which 3 types Nos. 21, 20 and 12, have proved definitely superior in yielding power to the local types. These types have been the subject of yield trials and Type 21 is proved definitely superior to all others in Bihar and has also given good results at Shahjahanpur. [F. J. F S.]

## Studies in Indian Barleys. (2) The Root-System. Rakhal Das Bose and P. D. Dixit. *Ind. J. Agric. Sci.* 1, 90.

This paper is a continuation of the studies in Indian barleys commenced by the senior author. The root-systems of 24 types of barley are studied and classified into 4 types—mesophytic, semi-mesophytic, semi-xerophytic and xerophytic. The authors show from the distribution of the

* A later and fuller account of the disease will appear in a subsequent issue of the *Indian Journal of Agricultural Science.*

different types how these forms are correlated with the soil and climatic conditions of the localities in which they are cultivated. Thus the "types placed in the semi-xerophytic and xerophytic groups of root-systems .. .. ........ ..... . have all originated from seed brought from the drier parts of the country... .. .. ......... .. ". A connection also exists between a deep root-system and a long growing season and between a shallow rooting habit and early maturity. Shallow-rooted types are the best yielders at Pusa and deep-rooted types do not do well. This observation agrees with those made by other workers in crops such as linseed. [F. J. F. S.]

## Mechanically Harvested Cotton : Spinning Qualities. C. D. Brandt. *Text. World*, 1930, 78, 980-981.

The mechanical harvester which strips off everything on the stalk provides the most rapid method of picking cotton. A test conducted in order to determine the effect of this method of harvesting on the spinning qualities of the cotton is described. In gathering cotton from the field, every second row of cotton was harvested by machine, while the rows between were hand-picked. Any chance of getting a difference in staple in the two lots was thereby eliminated. The two lots were subjected to identical conditions during processing; they were run through the same machines, at the same speeds, and with the same settings. Relative humidity was kept constant, and all other variables were eliminated. The results are given in graphical form. The total waste removed from the lot of machine-picked cotton amounted to 1·2 per cent. more than that removed from the hand-picked. It is evident, therefore, that the mechanical cleaning at present is not quite thorough enough. Even so, this small difference in cleanliness is said to be of little consequence. The final yarn produced did not show any noticeable difference in either cleanliness or evenness. Weft and warp yarns spun from the machine-picked cotton gave breaking strengths a little higher than those for the corresponding yarns spun from the hand-picked cotton [Extract from the *British Cotton Industry Research Association, Summary of Current Literature*, Vol. X, No. 20, dated 1st November 1930.]

## Lancashire Cotton Corporation : Progress Report. Sir Kenneth Stewart. *Times Trade and Engineering Supplt.*, 1930, 27, 41.

An account is given of the progress of the Lancashire Cotton Corporation's activities during the past eight months. Ninety-nine companies, controlling 9,250,000 spindles and 25,000 looms have joined the corporation and negotiations are in progress with 17 companies controlling 1,750,000 spindles, of which at least half will probably go forward at an early date. Progress has been made in the purchase of Indian cotton, the building up of a waste organization for the purchase, distribution and sale of waste products, the establishment of a central testing department, the establishment of four central direct selling organizations in Leicester, Nottingham, Yorkshire and Holland, the erection of a central winding plant equipped for highspeed winding, the equipment of winding shed for an extensive experiment on automatic looms, and the institution of a training scheme for future managers, salesmen, and administrative heads. Four standard yarns have been marketed up to date, of which the cheapest met with a most encouraging response. The successful increase in the sale of standard products has already enabled several mills to be restarted. The full programme for 1930 consists of the reconditioning of 19 mills. [Extract from the *British Cotton Industry Research Association, Summary of Current Literature*, Vol. X, No. 20, dated 1st November 1930.]

**COTTON : CULTIVATION IN CENTRAL ASIA.** *Leipz. Wochenschr. Text.-Ind.*, **1930, 45, 530, 554.**

An extract is given from a Russian paper in which the present state of cotton cultivation in Central Asia and proposals for its development are discussed. In 1922, the area under cotton was about one-tenth of the pre-war area. During the last five years there has been an increase in the area on which cotton is grown and in the number of cultivators, but very little change in the yield in spite of seed selection and the use of fertilizers. The lack of progress is traced to primitive methods of cultivation and labour, and transport difficulties. The Russian Government intends to develop cotton cultivation in Central Asia during the present five-year period. The area of cotton cultivation will be considerably increased partly by the replacement of grain and rice by cotton, and also by increasing the area of land under irrigation. Modern mechanical apparatus will be used and there will be a re-distribution of land and collective systems of cultivation. [Extract from the *Journal of the Textile Institute*, Vol. XXI, No. 10, October 1930.]

# NOTES

## INDIAN SECTION OF THE WORLD POULTRY CONGRESS, JULY 1930.

We have received for publication the following report by the Secretary to the Committee, Indian Section of the World Poultry Congress held in Great Britain in July 1930:—

I have just returned from England and am writing to report to you the result of our effort to take part in the World Congress. I can assure you that India's contribution added to the success of the Congress as a whole, and, in spite of lack of funds and the very serious difficulties that were encountered, we put up a national exhibit not less beautiful than other nations and very much better than many that I saw from other important countries.

The thanks of our Committee are due to the British Department of Overseas Trade deputed by the Empire Marketing Board to assist us.

We were allotted a generous free space in the most central part of the Crystal Palace. Most artistic and expensive representations of two Indian scenes (one portraying a nobleman's court and the other a peasant's mud house and *durba* of fowls) were staged at no cost to our Committee. Free lighting also was given us and every courtesy shown. It was an inspiring privilege to join the immense body of delegates that assembled from all parts of the world, all speaking many languages and yet all with one interest at heart, the promotion of good poultry throughout the world.

Our Committee's Indian bird exhibits were unfortunately destroyed by fire at sea—a most sad loss—but I was able to borrow a few pairs from breeders in England and to make good. The Indian exhibits attracted much attention and His Royal Highness the Duke of York, to whom I was personally presented on behalf of the Committee, when he visited our Section, was more than disappointed not to see the jungle fowl. Unfortunately the Raja of Mursan did not send any jungle fowl, and his Asils were too out of condition and ill to do justice as an Indian exhibit. For the next Congress to be held in Rome in 1933, we should take early steps to collect really first class exhibits of India's indigenous fowls, pheasants and wild jungle fowl, as they are more attractive, to the scientist and the general public as well, than the usual modern fowl, though I think we should also send Indian-bred specimens of modern breeds to show what has been achieved in India.

India was honoured at the Congress in every possible way, and lavish entertainments were given, by both the Government and leading notabilities of Great

Britain, to us all. Thousands visited us and plied us with questions about Indian poultry. I received many enquiries wishing to purchase jungle fowl and pheasants from India.

In conclusion, I should like to thank Sir Harcourt Butler for acting as our President, and all our Committee for their kind contributions; in particular I should like to mention the very practical help and interest taken in the matter by our Vice-President, His Highness the Maharaja of Sailana, and Piarey Kishen Sahib, the Dewan of that State. Our thanks are also due to Mr. Nur-ul-Islam for the birds he procured for us, to the Lucknow Zoo for jungle fowls (these, alas, perished in the fire on board the ship), and to Mr. Anand Lal Sah of Naini Tal, a student in England, who gave me unstinted help at great cost to himself.

## PRODUCTION OF SUGAR DIRECT FROM CANE DURING THE SEASON 1929-30.

Twenty-seven factories making sugar direct from cane worked in India during the season 1929-30 as against twenty-four in the previous season. Eleven of these are situated in the province of Bihar and Orissa, thirteen in the United Provinces, one in Bombay, one in Madras, and one in Burma. During the season under report, a new factory at Pilibhit, United Provinces started working under the proprietorship of the firm owning the factory already working there.

The production of sugar direct from cane by factories in India totalled 2,443,486 maunds or 89,768 tons during the season 1929-30, as against 1,852,322 maunds or 68,050 tons during the season 1928-29. There was thus an increase of 591,164 maunds or 21,718 tons in the output of sugar during the campaign of 1929-30 as against 1928-29.

The table below shows the quantity of cane crushed and sugar made by the factories in (1) Bihar and Orissa, (2) United Provinces, and (3) Bombay, Madras and Burma.

*Total for Bihar and Orissa.*

| | 1928-29 Maunds | 1929-30 Maunds |
|---|---|---|
| Cane crushed | 10,041,194 | 11,294,684 |
| Sugar made | 865,037 | 1,005,797 |
| Molasses obtained | 377,822 | 394,730 |
| Recovery per cent. | 8·61 | 8·90 |

*Total for the United Provinces.*

| | 1928-29 | 1929-30 |
|---|---|---|
| | Maunds | Maunds |
| Cane crushed | 9,920,660 | 12,982,302 |
| Sugar made | 830,491 | 1,167,992 |
| Molasses obtained | 425,397 | 466,508 |
| Recovery per cent. | 8·37 | 9·00 |

* *Total for Bombay, Madras and Burma.*

| | 1928-29 | 1929-30 |
|---|---|---|
| | Maunds | Maunds |
| Cane crushed | 1,579,004 | 2,664,723 |
| Sugar made | 156,794 | 269,697 |
| Molasses obtained | 58,957 | 102,149 |
| Recovery per cent. | 9·93 | 10·12 |

*Grand Total.*

| | 1928-29 | 1929-30 |
|---|---|---|
| | Maunds | Maunds |
| Cane crushed | 21,540,858 | 26,941,709 |
| Sugar made | 1,852,322 | 2,443,486 |
| Molasses obtained | 862,176 | 963,387 |
| Recovery per cent. | 8·59 | 9·07 |

*Figures for 1928-29 exclude Burma.

It will be noticed from the above table that, in the year 1929-30, the supplies of cane available for crushing were considerably larger in all the provinces than in 1928-29.

The average percentage recovery of sugar in India also shows an improvement, having risen from 8·59 in 1928-29 to 9·07 in 1929-30. The highest recovery is

shown by a factory working thick cane, its average for the whole season being 10·8 per cent.

During the season 1929-30 India's production of molasses by modern factories making sugar direct from cane totalled 963,387 maunds as against 862,176 maunds in 1928-29, or an increase of 101,211 maunds over the previous season.

If we take a review of the last five seasons' average percentage recovery of sugar from cane as given in the table below, we find the factory side of the industry showing a satisfactory improvement.

| Names of the Provinces | 1925-26 Recovery per cent. | 1926-27 Recovery per cent. | 1927-28 Recovery per cent. | 1928-29 Recovery per cent. | 1929-30 Recovery per cent. |
|---|---|---|---|---|---|
| Bihar and Orissa . . . | 7·98 | 8·67 | 8·80 | 8·61 | 8·90 |
| United Provinces . . . | 7·88 | 7·93 | 8·07 | 8·37 | 9·00 |
| Bombay, Madras and Burma . | 8·98 | 10·26 | 10·09 | 9·93 | 10·12 |
| Total for India . . | 8·07 | 8·49 | 8·62 | 8·59 | 9·07 |

Statistics regarding the production of refined sugar by refineries in India will be collected, collated and published in due course.

I take this opportuity of expressing my thanks to the Proprietors and the Managing Agents for supplying the statistics worked up in this note. [WYNNE SAYER.]

## CO. 281 CANE RELEASED FOR PUBLIC USE IN LOUISIANA.

It is learnt that the Coimbatore seedling Co. 281 is one of the two varieties recently released for public use in Louisiana. As this cane is under test in certain of the Experiment Stations in India, the following comments (*Facts about Sugar* **25**, 801) on this cane are likely to be of some interest.

Co. 281 has given best results in the river and bayou districts, and is chiefly valuable because of its high sucrose content, straight growth, and superior yields of sugar per acre. It takes mosaic, but is apparently as tolerant as the P. O. J. varieties commonly grown. It withstands early cutting much better than P. O. J. 234, and this advantage, combined with nearly equal earliness and superior yields, constitute an important advance in the development of an indispensable early milling variety. However, owing to its brittleness and injury by storms, it should never occupy a large proportion of the plantings". [T. S. VENKATRAMAN.]

## POULTRY FARMING CLASSES.

We have received for publication the following prospectus for the Poultry Farming Classes to be held at the United Provinces Poultry Association's Farm Lucknow, commencing on the 1st November each year.

### CONDITIONS.

1. Preference will be given to students who are residents of the United Provinces; non-U. P. students will be charged 50 per cent. enhanced fees above the rates quoted below.
2. All students should submit a recommendation from some responsible official or a letter from their Local District Board.
3. All fees must be prepaid at the following rates:—

| | Rs. |
|---|---|
| 6-weeks' course | 25 |
| 3-month „ | 50 |
| 6 „ „ | 100 |
| 1-year „ | 200 |

4. In order to reserve a seat, of which there are 10 only, the candidate must apply in writing to the Secretary as early as possible on the form supplied by the Association and pay a deposit of Rs. 10. Only on these conditions will the student be guaranteed a seat.
5. Students taking the courses must agree to attend the farm at appointed times each day, special holidays excepted, and to carry out such practical work as may be desirable. Also attendance at lectures is compulsory.
6. At the conclusion of each course there will be a final examination; students obtaining not less than 60 per cent. marks will be considered as passed and receive a certificate from us. Students gaining 75 per cent. and over will pass with honours. Students taking a six months' course or longer will receive our diploma, should they satisfy the examiner in both theoretical and practical work.

   Posts for qualified men cannot be guaranteed, but the Association will endeavour to assist such students as are fully qualified.
7. A hostel near the farm is provided at a fee of Rs. 5 per month per student. Students can make their own arrangements for board and lodging.

8. No charges beyond that of the premium will be made, except in the case of wilful damage, or through neglect or wilful disobedience of orders.
9. A student may be removed at any time during the period of training should he be found unsuitable in any way, and the refunding of his fees will be at the discretion of the Secretary.
10. The selection, and the limitation of numbers, of students rests with the Secretary.

## COURSES IN POULTRY HUSBANDRY.

*First Course.*—Consists of an elementary training in poultry farming for six weeks only, during which time the following subjects are taught :—

(*a*) Natural and artificial hatching of eggs.
(*b*) Natural and artificial rearing of chickens.
(*c*) Practical management of poultry.

Course commences 1st November and closes on 15th December. Fee Rs. 25.

*Second Course.*—Includes the above and, in addition, feeding, housing and treatment of disease is taught.

Opens 1st November and closes 31st January. Fee Rs. 50.

*Third Course.*—Includes breeding and mating of stock, preservation of eggs, fattening of fowls for table. How to keep poultry accounts and manage a farm.

Opens on 1st November and ends 30th April. Fee Rs. 100.

*Fourth Course.*—Includes an entire year's work on the farm through every season with thorough practical experience.

Opens 1st November and lasts throughout the year. Fee Rs. 200.

The knowledge of English is a very necessary asset to a student wishing to take the advanced course, but in order to meet the practical needs of U. P. men wishing to take only the elementary courses, all such tuition will be given in both English and the Vernacular.

Short elementary courses for U. P. men *only* will be arranged for whenever required during the winter season.

NOTE.—Messing can be arranged at Rs. 20 per student per month, provided there are four or more to join together

# Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

Dr. B. A. Keen, D.Sc., F.Inst.P., has been appointed Director of the Imperial Institute of Agricultural Research, Pusa, with effect from the 6th November, 1930.

Dr. W. H. Harrison, D.Sc., I.A.S., on being relieved of the duties of Officiating Director of the Imperial Institute of Agricultural Research, Pusa, has been appointed Joint Director of the Institute, in addition to his duties as Imperial Agricultural Chemist, with effect from the 6th November, 1930.

Mr. M. Afzal Husain, M.Sc. (Pb.), M.A. (Cantab.), I.A.S., Government Entomologist, Punjab, has been appointed temporary Locust Research Entomologist, Imperial Council of Agricultural Research, Lyallpur, with effect from the 5th December, 1930.

Rao Sahib Y. Ramachandra Rao, M.A., F.E.S., Government Entomologist, Madras, has been appointed temporary Deputy Locust Research Entomologist, Imperial Council of Agricultural Research, Quetta, with effect from the 20th December, 1930.

Dr. M. Sharif, D.Sc., has been appointed temporary Assistant Locust Entomologist, Imperial Council of Agricultural Research, Quetta.

Mr. S. M. A. Shah, B.Sc., M.R.C.V.S., Superintendent, Civil Veterinary Department, North-West Frontier Province, has been appointed a member of the Advisory Board of the Imperial Council of Agricultural Research.

MR. J. TINKER, of the Cawnpore Cotton Mills Company, has been nominated by the Upper India Chamber of Commerce to be a member of the Indian Central Cotton Committee, Bombay, *vice* Mr. H. A. WILKINSON resigned.

### *Madras*

MR. P. T. SAUNDERS, O.B.E., M.R.C.V.S., I.V.S., has been appointed Director of Veterinary Services, Madras, in the vacancy caused by the appointment of Mr. F. Ware as Director, Imperial Institute of Veterinary Research, Muktesar.

MR. T. J. HURLEY, M.R.C.V.S., D.V.S.M., I.V.S., has been appointed Principal of the Madras Veterinary College, *vice* MR. P. T. SAUNDERS appointed Director of Veterinary Services, Madras.

The services of RAO SAHIB Y. RAMACHANDRA RAO, M.A., F.E.S., Government Entomologist, Madras, has been placed at the disposal of the Imperial Council of Agricultural Research for appointment as Deputy Locust Entomologist.

MR. T. V. RAMAKRISHNA IYER, B.A. (Mad.), Ph.D. (Stanford), F.E.S., F.Z.S., Lecturer in Entomology, has been appointed Officiating Government Entomologist, Madras, *vice* RAO SAHIB Y. RAMACHANDRA RAO appointed Deputy Locust Entomologist, Imperial Council of Agricultural Research.

MR. T. MURARI, B.Sc., Dip. Rural Economics (Oxon.), Dip. Ag., F.L.S., Superintendent, Live-stock Research Station, Hosur, has been placed in charge of the duties of the Deputy Director of Agriculture, Live-stock, Madras, *vice* Mr. R. W. LITTLEWOOD granted leave.

### *Bengal*

MR. M. CARBERY, M.A., B.Sc., M.C., I.A.S., resumed charge of his duties as Agricultural Chemist to the Government of Bengal on the 28th October, 1930, on the expiry of his leave.

*United Provinces*

MAJOR W. H. PRISTON, F.R.C.V.S., I.V.S., Superintendent, Civil Veterinary Department, United Provinces, has been granted leave out of India on average pay for seven months and nine days, with effect from the date on which he was relieved of his duties in the Central Provinces.

RAI BAHADUR S. C. BANERJI, F.C.S., Officiating Assistant Agricultural Chemist to Government, United Provinces, has been granted leave on average pay for four months with effect from December 1st, 1930.

*Punjab*

MR. J. S. GAREWAL, M.R.C.V.S., I.V.S., has resumed charge of his appointment as Live-stock Officer and Assistant to the Director, Veterinary Services, Punjab (for Breeding), Lahore, on the 28th November, 1930, relieving MR. P. N. NANDA, M.R.C.V.S., who reverted to his substantive appointment as Assistant Superintendent (Stock) at the Government Cattle Farm, Hissar, from the same date.

MR. S. M. SARWAR, M.R.C.V.S., on being relieved by MR. NANDA, has been posted as Officer under training at the Government Cattle Farm, Hissar.

*Burma*

On return from leave, CAPTAIN J. B. IDLE, M.R.C.V.S., I.V.S., has been posted as Deputy Director of Veterinary Services, South Western Circle, Burma, with head-quarters at Bassein, in place of MR. S. R. RIPPON, I.V.S., who remains in charge of the South Eastern Circle.

On completion of his training, Mr. J. BHATTACHARJEE, M.R.C.V.S., Officiating Deputy Director of Veterinary Services, Burma, has been posted to the charge of the Central Circle, with head-quarters at Meiktila, in place of U NYAN GYAW, G.B.V.C. Veterinary Superintendent, who reverts to his substantive appointment.

## *Bihar and Orissa*

MR. SUBRATA KUMAR SEN, B.Sc., M.R.C.V.S., has been appointed an additional Special Officer in the Civil Veterinary Department, Bihar and Orissa, for a period not exceeding one year with effect from the 28th November, 1930, and attached to the office of Director, Civil Veterinary Department.

## *Central Provinces*

MAJOR R. F. STIRLING, F.R.C.V.S.. F.R G.S., D.V.S.M., F.Z.S., I.V.S., who has been permitted to return to duty before the expiry of leave granted to him, has been re-posted as Officiating Director of Veterinary Services, Central Provinces.

# NEW BOOKS

## On Agriculture and Allied Subjects

1. Practical Plant Biochemistry, by Muriel Wheldale Onslow. Third edition. pp. VII+206. (Cambridge University Press.) Price, 12*s*. 6*d*. net.
2. The Green Leaf : The Major Activities of Plants in Sunlight, by D. T. Mac Dougal. Pp. 142. (London : Appleton & Co.) Price, 6*s*.
3. The Future of Farming, by C. S. Orwin. Pp. 156. (Oxford : Clarendon Press.) Price, 5*s*. net.
4. Moulds, Yeasts and Actinomycetes : a Handbook for Students of Bacteriology, by Arthur T. Henrici. Pp. x+296. (New York : John Wiley & Sons, Inc. ; London : Chapman & Hall, Ltd.) Price, 17*s*. 6*d*. net.
5. Year-Book of Agricultural Co-operation, 1930, edited by the Horace Plunkett Foundation. Pp. VI+576. (London: George Routledge & Sons, Ltd.) Price, 10*s*. 6*d*. net.
6. Genetics and Eugenics : A Text-book for Students of Biology and a Reference Book for Animal and Plant Breeders, by W. E. Castle. Fourth revised edition. Pp. 474. (Harvard University Press.) Price, 12*s*. 6*d*.
7. International Directory of Pedigree Stock Breeders, Vol. III, 1930-1931. Pp. 1100. (London : The Vernon Press, Ltd.) Price, 20*s*. net.
8. Animal Breeding, by Laurence M. Winters. Pp. x+389. Illus. Second edition. (New York : John Wiley & Sons, Inc. ; London : Chapman & Hall, Ltd.) Price, 18*s*. 6*d*. net.

The following publications have been issued by the Imperial Department of Agriculture since our last issue :—

*Memoir.*

Cotton Growing in India in relation to Climate, by Trevor Trought, M.A., and Mohammad Afzal, B.Sc. (Agri.), A.I.C.T.A. (Botanical Series Vol. XVII, No. 5.) Price, As. 12 or 1*s*. 3*d*.

*Catalogue of Indian Insects.*

Carabidae, by H. E. Andrewes. (Part 18.) Price, Rs. 8 As. 10, or 14*s*. 6*d*.



MGIPC—S1—III-1-137—19-3-31—2,000

# ORIGINAL ARTICLES

## INEFFICIENCY OF CATTLE IN INDIA THROUGH DISEASE.

BY

LT.-COL. J. MATSON, O.B.E., I.A.

IT is a commonplace of the "cattle question" that vast numbers of Indian cattle are so hopelessly inefficient as to have no commercial value beyond that of their hides.

The fact is commonly ascribed to overpopulation and that is the chief cause, but recent observations suggest that it is by no means the whole story; that in fact, if there were no disease, a substantial proportion of the useless emaciated specimens one sees would be marketable cattle.

I write this while in camp in the heart of the Central Provinces jungles. The local village cattle go to graze in the forests two hours after sun up and return one hour before sun down, it is cold weather—a hard frost every night—yet the majority are in very good condition; in fact, I have never seen a village herd in better condition; Nevertheless the well conditioned animals are a majority only—some 30 per cent. are less good. These include the old, naturally, but of the 30 per cent. 20 are young animals which vary in condition between "rather poor" and emaciation. The explanation of the 20 per cent. lies, I suggest, in the prevalence of various blood parasitical diseases. To these diseases the cattle acquire a sufficient tolerance, in youth, to prevent an active manifestation later but insufficient to permit of vigorous good health when the re-infection which goes on all the time becomes massive in a particular individual. One can of course dismiss such cases by saying "Oh! yes. Bad doers. All cattle produce a proportion of bad doers." But a "bad doer" is such through some specific cause, and in the case of Indian cattle, whose metabolic efficiency is very high, I doubt if such unthrifty specimens as I describe lack any of the hereditary qualities of their fellows. I think they occur simply through the chances of greater or less infection.

On the Military Dairy Farms we have adopted the practice of taking blood slides from cattle which lose condition and have found in the great majority either *Babesia bigeminum* or *Theileria mutans*, and surra in a few. In the case of *B. bigeminum*, injection of Trypan Blue has produced astonishingly rapid recovery to good condition. One cannot assert that a specific for the other cases exists as

yet but even if certain cures can be found, prevention is greatly to be preferred. For that purpose regular dipping appears to be the best thing. It has been tried on two military farms with highly satisfactory results. On the Belgaum farm, for instance, ticks are thick everywhere, on the standing grass, in the hay stacks and in every crevice of the buildings, and my predecessors had been compelled to give up keeping cross-bred European cattle there. But since putting in a dip we have been able to rear this class of stock in perfect condition.

The prominent cattle diseases of India may be divided into two groups. Those that kill but do not maim and those which rarely kill but injure more or less permanently.

Rinderpest is typical of the first group. I think it is not inaccurate to say that a preponderating part of the time, money and effort, available for control and prevention of disease in live-stock, has been devoted to it, and obviously it is very necessary to keep rinderpest within bounds and to make it at least possible for the owner of valuable stock to protect them; nevertheless I seriously doubt if rinderpest is the worst enemy of cattle-owners in the mass. It kills a large proportion of the animals attacked but an animal that recovers is as efficient as before. An epidemic may ruin an individual farmer, but that it does great harm to the community, when the stock is in excess of what the food supply can support, is open to doubt.

On the other hand, the group of diseases which takes in the piroplasms and trypanosomes—granted infection in early life, which is usual— causes little mortality but leaves great numbers injured. A disease which continuously attacks 10 to 20 per cent. of a herd and, while reducing their efficiency to zero, leaves them alive to continue to eat a share of the available food is probably a worse thing than one which by periodical destruction of 10 to 20 per cent. on the average of years destroys only 3 to 5 per cent.

[The above note, furnished by Lt.-Colonel Matson, being the considered opinion of one who has made a close study of large numbers of Indian cattle, maintained under strictly controlled conditions and carefully recorded observation, is of exceptional authority. It draws attention to an aspect of the cattle problem of India which is apt to be overlooked because of its insidious nature, *viz.*, the degeneracy caused by blood diseases and parasitic infestations which, though they do not usually cause heavy mortality, are responsible for the existence of large numbers of cattle which are quite unprofitable to maintain and unfit to breed from, and therefore a source of heavy loss to the agricultural community. (A. O.)]

# THE COCCIDAE OF THE PRICKLY-PEAR IN SOUTH INDIA AND THEIR ECONOMIC IMPORTANCE.*

BY

T. V. RAMAKRISHNA AYYAR, B.A., PH. D., F.Z.S.,

*Offg. Government Entomologist, Madras.*

It is common knowledge that in South India, except in a few tracts like the West Coast, the prickly-pear (*Opuntia*) enjoys a very wide distribution all over the plains. In districts like Tinnevelly, Madura, Trichinopoly and Coimbatore it is found growing luxuriantly, covering acres and acres of arable and pasture lands and levying a substantial toll on the farmer every year to keep it within certain bounds. The problem of the disposal of this plant, either by utilisation or by destruction, has been engaging the attention of the public and the authorities for the past many decades One of the control measures tried in this connection has been the use of the natural enemies of this plant. Among these latter, the most important are insects belonging to the family Coccidae which includes scale-insects and mealy-bugs. For over ten years in the past the writer has been paying some attention to the systematics and bionomics of South Indian Coccidae and during the course of such investigations he has had chances of observing and studying insects on the different species of Cactaceæ found growing in the country. In view of the fact that a new prickly-pear Coccid has gained entry into the country, it is thought that a paper on the subject may not be inopportune. In this paper an attempt is made to record the results of the writer's studies of the Coccidae of the prickly-pear and their economic importance, and at the same time to review briefly the previous attempts in the control of prickly-pear by insect agency.

## KINDS OF PRICKLY-PEAR IN SOUTH INDIA.

Before coming to the entomology of the prickly-pear plant it will be advantageous and even necessary in some cases to have some idea of the different kinds of prickly-pear (*Opuntia*) found growing in South India. As is well known, this plant is an exotic form being a native of the tropical and sub-tropical regions of the New World. Previous records on the subject show that different species of *Opuntia* were introduced into the country somewhere about the middle of or early in the second half of the eighteenth century, at any rate, earlier than 1787 during which year Dr. J. Anderson, the Physician-General of the East India Company, was running a

* Paper read at the Agriculture Section of the Indian Science Congress, Nagpur, January 1931.

prickly-pear farm in Madras; it appears this officer had also distributed different kinds of prickly-pear for propagation in different parts of the province by that time. As such, it has practically become a naturalized plant, having been in the country for well nigh one hundred and fifty years. The species of *Opuntia* now found in South India are :—

(*i*) *Opuntia monacantha*, Haw. (Plate XIV, fig. 1.) Found here and there in the Northern Circars; observed also around Madras and near about Coimbatore, but it has become very rare. The chief distinguishing feature of this species is the possession of single straight spines, which are dark at the apex, on the elongate oval bright green joints; the petals of its flowers have also a reddish tinge outside. It is found to prefer moister and shaded conditions. As will be noted below, this species has played an important part in connection with the early experiments in raising the Cochineal dye and the natural control of prickly-pear by insect agency.

(*ii*) *Opuntia Dillenii*, Haw. (Plate XIII.) Found in some places from Ganjam to Madras and almost everywhere in the central and southern districts; is not found along the West Coast tracts of Malabar, South Kanara and Travancore. This is the commonest prickly-pear found in South India. It is easily recognised by its greyish green joints, yellow flowers, purple fruits, and straw-coloured curved thorns; unlike as in *monacantha* the spines are found in groups of short and longer ones and the petals of the flower are yellow outside.

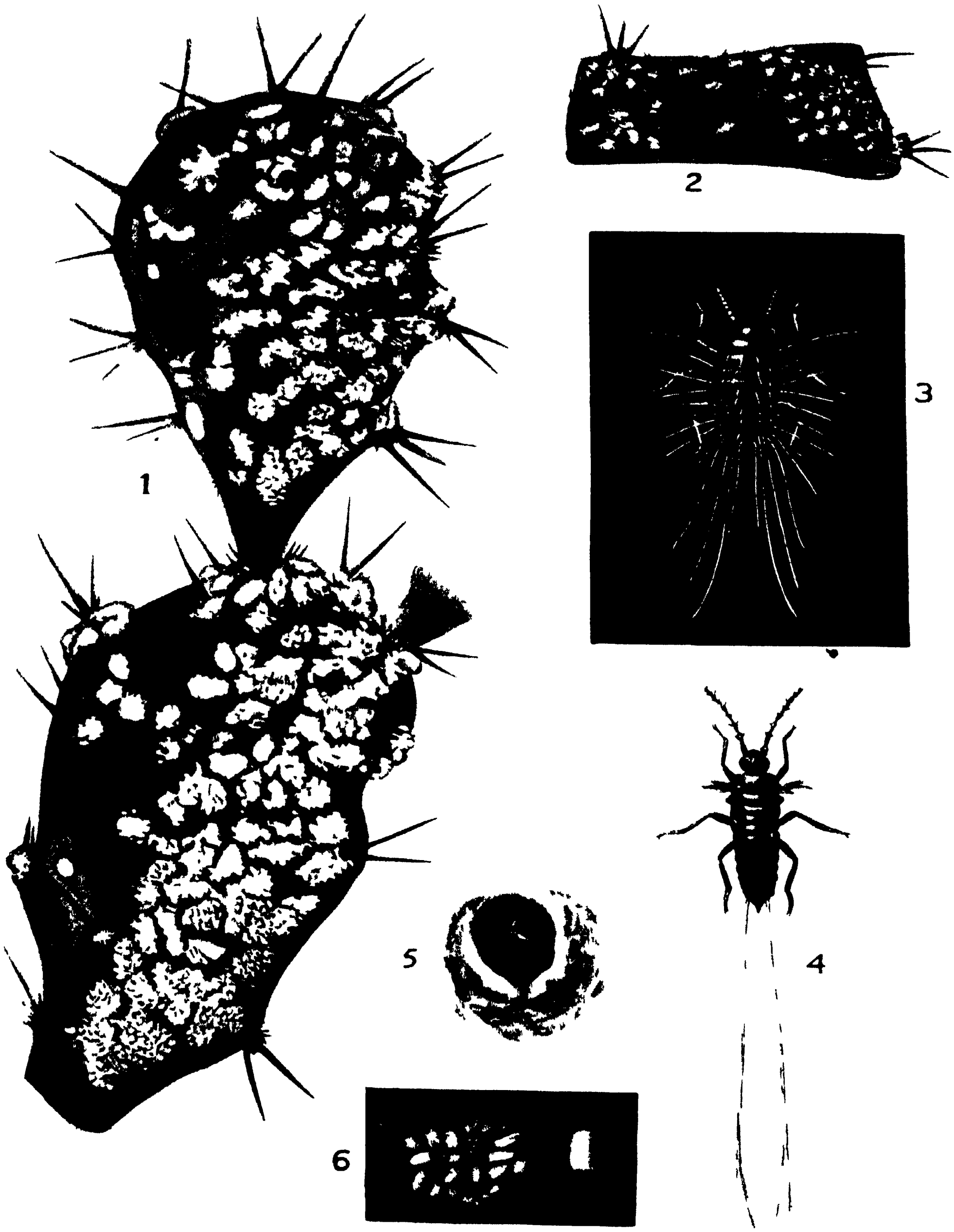
(*iii*) *Opuntia nigricans* (*O. elatior*, Mill). Found in the Northern Circars along the coast and in parts of Bellary. This appears to be the commonest form in the Southern Maharatha Country and in Northern Bombay. In general characters this species is very close to *O. Dillenii*, but has rose pink flowers.

However sincere and praiseworthy the wisdom and the motives which prompted the early introduction of these species of prickly-pear into the country, the results, as is evident from the present state of affairs, are unfortunately deplorable in that the plant has become a terrible pest in its new home. This is on a par with the unwise introduction of the rabbit into Australia and the mungoose into the West Indies!!

### INSECTS ON PRICKLY-PEAR.

In their original homes in the New World the different species of *Opuntia* are found attacked by numerous insects such as beetles, caterpillars, flies, bugs, etc., etc., but in South India, as far as the writer is aware, these plants are subject to the

PLATE XIII




THE NEWLY INTRODUCED WILD COCHINEAL (*Dactylopius tomentosus*, L.).

1, *Opuntia Dillenii* infested by *D tomentosus* 2, Young and growing larvæ settling on fresh pear (× 48) 3, Larva (× 48) 4, Adult male (× 48) 5, Adult female with a cottony cover moved aside (× about 5) 6, Cluster of male puparia with males emerging (× about 3), one enlarged (× about 5).

PLATE XIV.

Fig 1 *Opuntia monacantha*

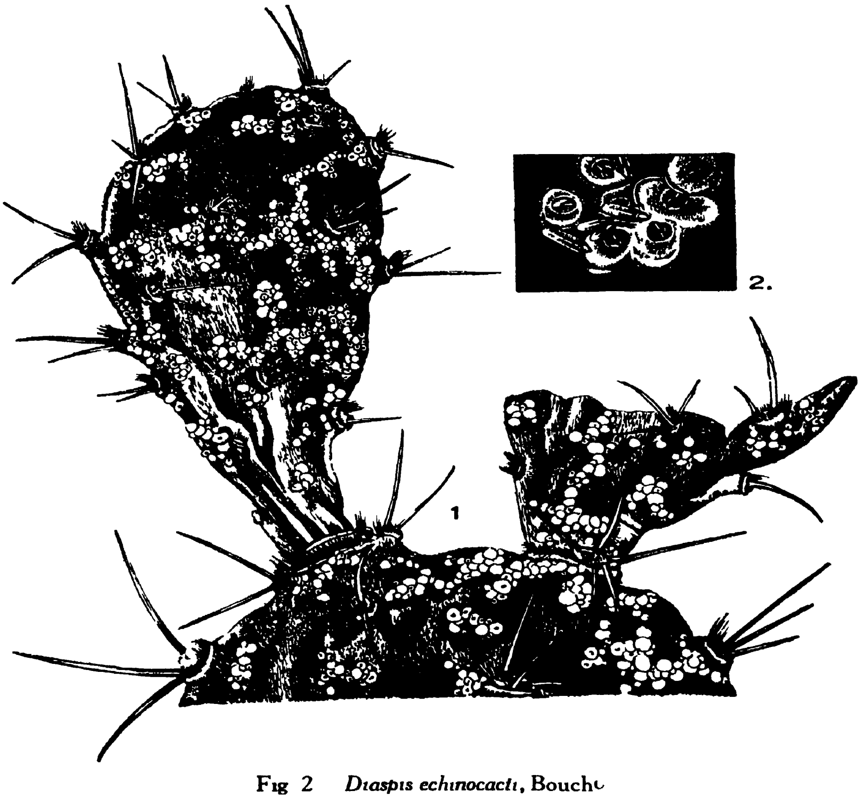



Fig 2 *Diaspis echinocacti*, Bouché
(1) Scales on prickly pear (*O Dillenii*), (2) Male and female puparia, magnified.

attentions of very few insect enemies, and this is evidently one of the reasons why this exotic plant, free from the attacks of many of the enemies it has to contend against in its native home, has thriven so well in its adopted land and has become a formidable pest of first class importance! With the exception of the common orange-banded blister beetle (*Zonabris pustulata*) which is often found feeding on the flowers of prickly-pear and which is not in any way partial to *Opuntia*, the only important insects so far found on prickly-pear are three species of scale-insects (Coccidae). It has been found by experience that all these Coccids are exclusively cactus-feeding forms and have not been found till now to breed on any other food plant; this, of course, means that they have entered the country with the host plant and are also exotic forms. The three species of Coccidae are :—

The white scale of prickly-pear—*Diaspis echinocacti*, B. This belongs to the group of hard or armoured scales. The female scale is oval (Plate XIV, fig. 2) or circular and slightly convex; in colour it is pale white, sometimes with a tinge of yellow; the exuviae central or subcentral and of a brown color; measures 1 to 1·5 m.m. across. The male scale is narrowly elongate and feebly carinate, if at all; colour white, measures 1·5 m.m. in length and 0·5 m.m. in width. The adult male is a delicate two-winged form with orange brown body and creamy white wings. This insect is fairly common in almost all the regions in the tropics—wherever prickly-pear has found its way. In India it was noted for the first time on *Opuntia* in 1896 by Sir George Watt [1899] in South India. It was later noted in Poona by Lefroy [1908] and Kasergode [1914]. Ever since 1916 the writer has noted it on prickly-pear in Coimbatore and the adjacent districts; he has also recorded the same in a paper on "South Indian Coccidae of Economic Importance" read at the session of the Indian Science Congress at Lahore in 1918 [Ramakrishna Ayyar, 1919, 1] and also in his Bulletin on South Indian Coccidae published the following year [Ramakrishna Ayyar, 1919, 2]. Recently he has collected it on the cactus *Cereus* in South Arcot [Ramakrishna Ayyar, 1930, 1].

Though the host plant is often found extensively covered with colonies of this insect, it is rarely found to suffer seriously or get destroyed. A minute chalcid parasite has been noted by the writer to attack this scale and it is not unlikely, therefore, that some natural enemies like this parasite exert some influence in checking its effective multiplication.

The two other Coccids are unarmed scales belonging to the group of mealy-bugs, and are species of what are popularly known as "Cochineal" insects; both belong to the genus *Dactylopius*. Unlike as in the previous scale, these insects are covered not by a hard shield but by a profuse secretion of white cottony or mealy matter, and this latter has to be removed to make the adult female insect visible

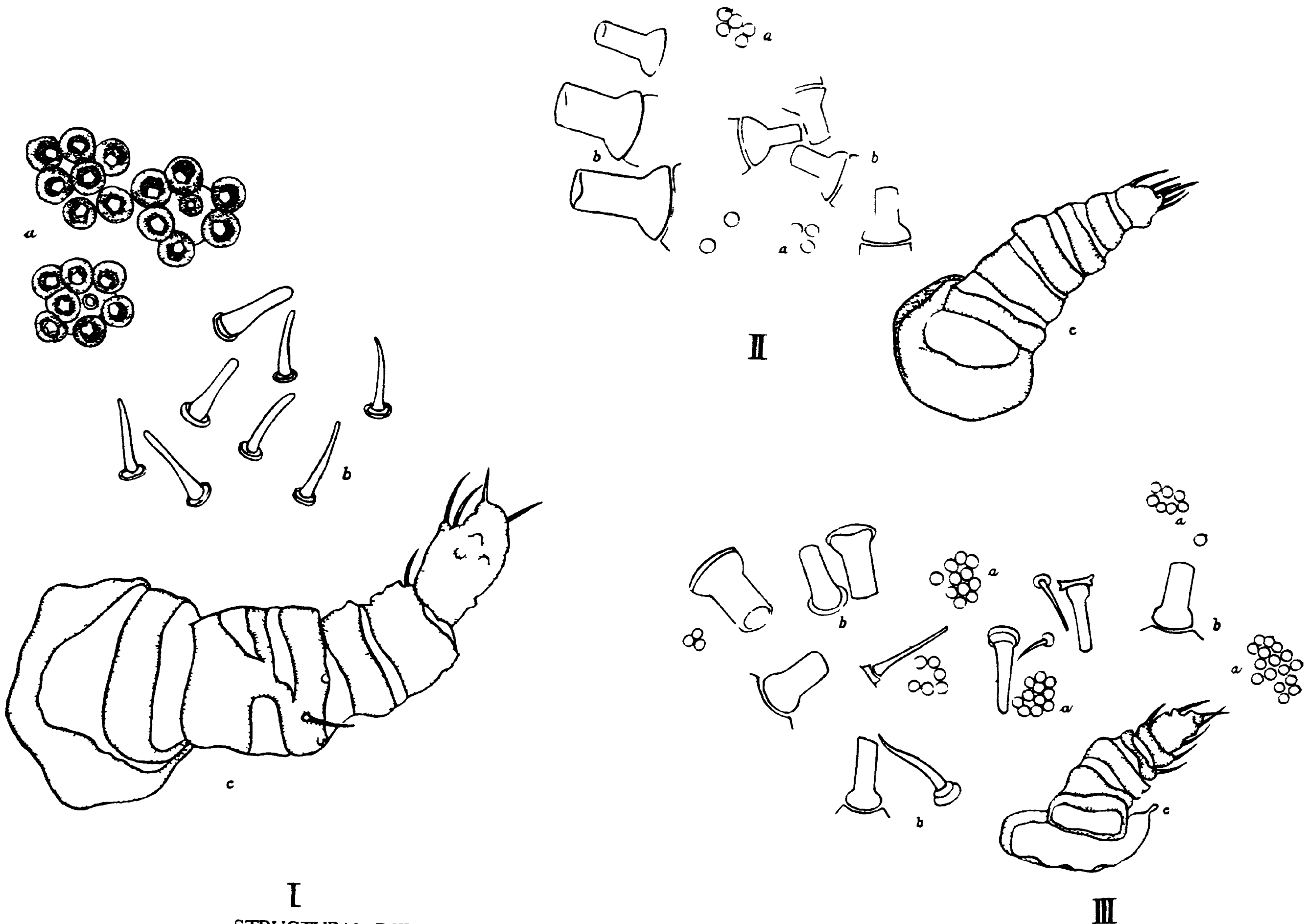
(Plate XIII, fig. 5). The adult male (Pl. XIII, fig. 4) is a two-winged active creature with the body red and the wings cream white; it has two long slender waxy processes at the hind end. These insects give out a brilliant deep red or crimson dye, called the "Cochineal dye". In the main general characters both the species are alike, the differences found being only in some minute details. To the naked eye the two forms appear similar, it being difficult to differentiate them except by microscopic examination of the structural features of the adult female. The following brief descriptions are prepared from specimens in the possession of the writer; and they have been compared and checked with the descriptions of these species by Green [1912, 1922], and Newstead [1902]. The minute details are omitted here. The two species are:—

(*a*) *Dactylopius indicus*, Green. *Female insect*—General form oval or more or less globular in outline—2 to 4 m.m. across in measurement; general colour when the mealy covering is removed de brownish red. After epto treatment in potash and mounting as a microscopic preparation the following features are made out:—

The body is fringed with characteristic truncate spines (Plate XV, II); in prepared specimens these are found arranged in broad segmented bands—especially at the abdominal region. In addition there are numerous circular pores on the derm occurring singly or in clusters of three or four—rarely of more than six. Antenna has usually seven joints—in the specimens with the writer only six are clearly made out, which is evidently due to the fusion of the third and fourth joints. All the joints except the distal are broader than long and the distal is as broad as long; there are stout bristles on the distal and one on each of the two penultimate joints also. Legs moderately stout, tarsus longer than the tibia, and with a sharp claw and four clubbed digitules. The male puparium is snow white,' elongate cylindrical and found in clusters on the host plant. The adult male is of the usual type with the two long white caudal filaments, the minute eyes, the ten-jointed antennae and the two snowy wings.

This (*Dactylopius indicus*, Green) insect was the first Cochineal insect that was introduced into India, and the history of the introduction and the career of this insect are very interesting. Various early records show that a consignment of this species was first introduced into India in the year 1795 by one Capt. Neilson; he brought it to Calcutta and handed it over to Dr. Roxburgh of the Botanical Gardens, where the propagation of the insect was started on prickly-pear. A portion of this material appears to have been forwarded to Madras where Dr. Anderson started the cultivation of the insect in his prickly-pear farm. Further introductions of the same insect appear to have been made at different periods subsequently. It has to be noted here that those responsible for these introduc-

PLATE XV.




STRUCTURAL DIFFERENCES BETWEEN THE THREE DIFFERENT COCHINEAL INSECTS

I *Dactylopins cacti*—genuine Cochineal II, *D indicus*—wild Cochineal, III, *D tomentosus*—wild Cochineal

*a* Dermal pores, *b*, Spines, *c*, Antenna

tions evidently mistook this insect for the genuine Cochineal (*Dactylopius cacti*), though it was found out later that it was only a wild form of the genuine Cochineal, and from a commercial point of view very inferior to the true Cochineal in every respect. Though for a few years the industry with this wild Cochineal thrived, it gradually lost its importance and the work was given up. The insect all the same continued to gain ground and gradually began to seriously tell upon its host plant in different parts of India, and by the middle of the last century it was found that this insect had done remarkable work in killing prickly-pear, as may be seen from the writings of Buchanan [1807], Ainslie [1813] and Wilks [1817]. But in parts of the Madras Presidency, especially in the Central and Southern districts, the prickly-pear still continued to be a formidable pest during the succeeding decades. The Madras Government desirous of checking its disastrous spread suggested the trial of this wild Cochineal in the Trichinopoly District, but this proved a failure. Again, at the instance of the Board of Revenue, Dr. Bourne and Mr. Thurston made some trials on the local prickly-pear with this insect, which had meanwhile become rare and which had to be got down from some corner of Ganjam. These trials also produced negative results. It is very important to note at this stage that these experiments tried from 1872 on to 1898 were all unfortunately vitiated by a *fundamental error, viz.*, the lack of sufficient biological knowledge regarding the food habits of the Cochineal insect tried and the different species of prickly-pear treated! The most important point grievously overlooked was the fact that *D. indicus*, the Cochineal insect tried with, fed only on one species of *Opuntia*, *viz.*, *O. monacantha*, and did not thrive on the other species *O. Dillenii*, and it was on the latter species that all the trials were made, with, of course, negative results. The unfortunate thing that happened was that the authorities did not know that all the good work of checking prickly-pear done in the past years by this insect was in connection with only one kind of prickly-pear, the *monacantha* species, and not with the commonest species of S. India—*Dillenii*. This is one of the best examples to show how important it is to possess definite ideas of the biology of the different animals and plants, before any such measures in biological control are thought of, since the habits of even very closely allied species often differ markedly. It was left to Burkill [1911] to point out this mistake later in 1911. He says referring to other species than *monacantha* " that his work will prevent any waste of money in fruitless attempts to destroy prickly-pear by means of the Cochineal insect; such as have been made in the past have been made in ignorance of the true food plants of that little insect ".

Meanwhile both the insect (*D. indicus*) and the host plant (*O. monacantha*) became rare in the country and the Queensland Prickly-pear Travelling Commission which toured India in 1914 wrote thus : " One species of prickly-pear (*O. monacantha*)

has evidently been very widespread throughout India in years past, but is now relatively uncommon in North India and practically extinct in South India. This result has been brought about by the wild Cochineal—*Dactylopius indicus*, G. Inquiry, supplemented by personal observations in the course of extensive journeys in the Madras and Bombay Presidencies and in the State of Mysore, failed to bring to light any quite recent instance of the wild Cochineal insect's occurrence." The writer was, however, able to collect this insect in 1916 in the Bhimavaram and Mandapetta villages of the Godavari delta on *monacantha*, as recorded in his Bulletin on Coccidæ [Ramakrishna Ayyar, 1919, 3]. He carried the material to Coimbatore and tried it on *Dillenii*, but the trial only confirmed the negative results obtained years ago. It is possible that this insect, though rare, may be found here and there in some parts of the Northern Circars.

(*b*) The second species is *Dactylopius tomentosus*, L. (Plate XIII.) In the general morphological features and life-history this species is more or less similar to *indicus*. As stated once above, it is difficult to identify either of these by a mere naked eye examination. The main differences between the two species are—

(*i*) The adult female of *tomentosus* is smaller than *indicus*.

(*ii*) The 7th antennal joint in *tomentosus* is slightly longer than broad.

(*iii*) In *indicus* the dermal pores are comparatively small and inconspicuous and are usually found only in groups of 3 or 4, while in *tomentosus* the pores occur in large clusters of 2-16 (Plate XV).

(*iv*) The truncate spines, though numerous, are comparatively longer than the breadth of their bases in *tomentosus*, while in *indicus* the basal portion is very broad (Plate XV). For detailed technical description of the different kinds of Cochineal insects reference may be made to Green's paper in the *Journal of Economic Biology* [1912].

The most important difference, however, between the two species is in the *food habit*: repeated trials have proved that *indicus* breeds only on *monacantha* sp. of pear, while *tomentosus* is found to breed freely on *Dillenii*. *D. tomentosus*, which is also a wild Cochineal, is quite new to India; it was towards the end of 1914 that the Ceylon Government received a consignment of this American insect from the Commonwealth Prickly-Pear Commission of Australia [1926]. In January 1929, while on tour in Koilpatti, this insect attracted the writer's attention who found it thriving pretty well on the common species of *Opuntia* (*O. Dillenii*) in that locality. On being told that it was introduced from Ceylon *via* Tuticorin, Dr. Hutson, Government Entomologist, Ceylon, was written to, and he was kind enough to inform the writer that a consignment of this insect (*D. tomentosus*) was sent to the Madura Co., Ltd., in Tuticorin, at their request, late in 1926, and that

the latter had reported about the good work of the insect in checking prickly-pear. Since then the writer has noted the rapid spread of this insect into the adjacent districts, chiefly Madura, Ramnad and Tanjore, and he has had letters of enquiry on the subject from the Health Officers of Negapatam and Cuddalore.† Before dealing with the economic importance of the different Coccids noted above, it will not be out of place to add a few words regarding the true Cochineal insect--*Dactylopius cacti*, L. This latter is a native of Mexico, though it has latterly been cultivated in West Indies, Peru, Africa, Canary Isles, etc. It shows definite differences in size structures, etc., as compared with the wild species; it is bigger in size and does not possess as much of the thick mealy white covering as in *indicus* or *tomentosus*; the dermal pores appear in large clusters and possess thick rims, which is quite a distinct feature of this species; the truncate spines are very inconspicuous and are slender and often taper (Plate XV). From the commercial point of view it is considered to be far superior and finer compared to the wild forms; in trade circles the former has been known as '*Grana fina*' and the latter as '*Grana sylvester*'! About ten years ago the writer came across a dry dye-stuff used by the silk weavers of Kollegal in South India known under the name of '*Krimınji*'; on examination, the material was found to be dry specimens of a Coccid; on preparing and examining it microscopically it revealed itself to be the real Cochineal, *D. cacti* [Ramakrishna Ayyar, 1930, 2], and the writer's identification was subsequently confirmed by Mr. Green, the greatest authority on the group. The dye used for the famous Kollegal silk towels in deep crimson and red colour is this stuff—the genuine Cochineal imported into India from Europe or America.

## Economic importance of prickly-pear Coccidae.

Very little remains to be added under this head, since a good deal has been said in speaking about each insect. Of the three Coccids, *Diaspis echinocacti* is of less importance at present from an economic point of view, though it is worth while watching the work of the insect and its relations with its food plants. As to the other two, though their original importance as Cochineals is now ignored, it is evident that both are economically very important—each in checking a particular kind of prickly-pear—*indicus* for *monacantha* and *tomentosus* for *Dillenii*. It is apparent from the present scarcity of the former pair that *indicus* has almost finished its work with *monacantha*. With regard to *tomentosus* it has only just entered the country, and in view of the fact that it breeds well on our commonest species of prickly-pear, *O. Dillenii*, it will have plenty of useful work before it. How successful the experiments of 1872-98 would have been if only this insect was used instead of *indicus* !! And the country would have been comparatively free from prickly-pear by now! The writer understands that consignments of this insect are being

sent to different parts of the country from Tinnevelly and Madura where the insect had made itself felt; if this Cochineal spreads, as it is doing at present, without any set-back, in the course of a few years the appearance of our countryside would be quite diffeient and prickly-pears will become rare plants. The probable set-back might be the advent of parasites; for the past two years during which period the writer has observed and studied this insect at close quarters no parasites have been found. But it is not unlikely that native species of lady-bird beetles, Chrysopas, flies and hymenoptera, which attack indigenous mealy-bugs, might under different seasonal conditions take a fancy for this Cochineal insect : in such a case the smooth, triumphant progress of the newcomer may receive a check. It is the writer's idea to watch this aspect of the subject of parasitism and study the life-history, habits and progress of the Coccid under different seasonal and local conditions. With regard to its food habits there is absolutely no reason to apprehend that it will feed on any plants other than Cactaceæ; this has been established long ago. It is however the intention of the writer to watch and study on what all cactaceous plants this insect would feed. So far the writer has not come across any one who really feels the introduction of this prickly-pear enemy as undesirable; perhaps. there may be some who are interested in the retention of prickly-pear!

In introducing this insect to new tracts it is advisable to inoculate insect material to shady parts of prickly-pear clumps and avoid doing so during rainy or windy weather, so that the minute crawling larvae and the delicate-winged males may not be seriously affected or killed. Under favourable conditions within a week after infection the minute red larvae begin to crawl over the joints of the growing plant, and in another week or ten days these settle themselves in convenient spots in groups and begin to cover themselves with the white cottony pubescence (Plate XIII). Gradually the plant surface becomes covered with broad white patches of the cottony pubescence, and clusters of minute tubular white cases appear among them; from these latter the winged adults emerge and fertilize the stationary female insects. During the period when these small delicate-winged males emerge, swarms of them are found in the air near prickly-pear areas like gnats; these are quite harmless and after mating with the female insects die away. After this, the female insects continue to grow vigorously secreting the white mealy covering profusely. In about 45 to 50 days the insect passes through one life-cycle under favourable conditions, and in this way the colony rapidly multiplies and covers prickly-pear plants in white cottony masses. Within a few months big clumps of infested prickly-pear begin to die out. Some care and attention during the earlier stages of the trial will help the insect in getting itself well established in new localities. It is conceivable that in a few decades this insect and its host plant *Dillenii* might become scarce like *monacantha* and its parasite *indicus*. It is advis-

able, therefore, not to allow such organism to die out; for this purpose the two plants with their respective Cochineal parasites may be cultivated under proper control in some of the botanical gardens so that they be at hand for any future needs. This is suggested in view of the fact that at present while *monacantha* prickly-pear may be found here and there, its specific parasite *indicus* is now very scarce.

A word or two in connection with the introduction of exotic plants and animals into the country may not be out of place here. So far as the writer is aware the introduction of this new Cochineal (*tomentosus*) appears to have been made by a private party, and it is doubtful whether the authorities had any warning or intimation about the affair. In such cases it is highly desirable that very great caution and care should be exercised, and the Government should alone possess the right to allow or disallow such foreign introductions, and a strict system of baggage examination and quarantine should be instituted at all ports of entry. Though in this particular case the immigrant happens to be a beneficial agent so far, it is not unlikely that undesirable kinds of plants and animals may gain admission into the country through the careless acts of irresponsible parties. and permanent and often irreparable harm may be caused to the country, as in the case of the recent introduction of an undesirable scale-insect (*Icerya purchasi*) into the Nilgiris.

In conclusion, the writer wishes to add that he ventured to prepare this paper not only because the insects are Coccidae and fall within the sphere of his special line of study, but also due to his anxiety to bring to the notice of the public the great economic importance of these Cochineal insects—especially of the newly introduced species—to the agriculturist all over the country. If the paper helps in any way to serve this purpose, he would feel amply rewarded.

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# BENEFICIAL EFFECTS OF POTASSIUM IODIDE IN CASES OF DELAYED SHEDDING OF CALF HAIR.

BY

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In the crossing of Indian and European cattle the first cross is almost invariably healthy and strong, but the second cross to the European, *i.e.*, progeny of the hybrid female mated to the European male again, when certain European breeds are used, develops characters which, when occurring together, are lethal for practical purposes in those parts of India where the highest temperatures are experienced.

Five different characters have been identified, up to now, by a process of mating the hybrids together and so obtaining in different individuals the expression of each character singly. Among them is one in which the long hair, characteristic of nearly all calves at birth, is not shed as the animals grow, but remains and, in the summer, is erected. The animal is then always unthrifty and milk yield falls off, usually resulting in its being weeded out. The incidence of such cases is much lower at some stations which enjoy relatively cool climates, as for instance on the 2,000 ft. elevation plateaus of Central India, and animals displaying the condition have become normal on being moved to such stations from, for instance, the hot plains of the Ganges valley. It appeared reasonable to suppose that, in all these manifestations of ill health, nutrition is defective, and the question arose whether it would be possible to discover what element in particular the animal was unable to assimilate from its food. For this character, namely, delayed shedding of calf hair, it was found that potassium iodide was beneficial as shown by the following :—

1. In the spring of 1928, two four-year-old affected cows were put on a regular average of 10 grains of potassium iodide once a week. At the end of two months the hair began to loosen and come away and the coat became normal. The treatment was discontinued and they have remained normal for over a year since. Following this a calf (Plate XVI, fig. 1) which showed no sign of shedding its hair was similarly treated with 4 grains potassium iodide for two months and similarly became normal as in Plate XVI, fig. 2.

2. In October 1928, 3 oz. potassium iodide was added to every 100 lb. of the mineral mixture (bone-meal, lime, etc.) which for some years we have

Fig. 1.

Fig. 2.—Fig. 1 after treatment.

PLATE XVIII.

Fig. 1.

Fig. 2.—Fig. 1 after treatment.

Fig. 3.

Fig. 4.—Fig. 3 after treatment.

PLATE XVII.

Fig. 1.

Fig. 2.—Fig. 1 after treatment.

Fig. 3.

Fig. 4.—Fig. 3 after treatment.

been giving to all our cattle (with apparently highly beneficial results as regards milk yield, resistance to contagious abortion and Johne's disease) at which time there were some twenty affected animals scattered over the various farms under my control. Examples are seen in Plate XVII, figs. 1 and 3, and Plate XVIII, figs. 1 and 3.

Making a tour in March 1929, there appeared to be some change for the better in their appearance, but it was too slight to justify conclusion. Now, however, on making another tour in September, after returning from furlough, I have found them completely cured without exception. Plate XVII, figs. 2 and 4 and Plate XVIII, figs. 2 and 4 show the cured condition.

Plate XVIII, fig. 4 is an outstanding case. She was most unhealthy in the first four lactations which varied between 3,000 and 5,000 lb. She has now a remarkable appearance of good health; her lactation beginning August 1928, *i.e.*, containing part of the period of iodine feeding, produced 6,090 lb. She has calved again in September 1929 and promises to give well over 7,000 lb.

## Conclusion.

In regard to the first three cases mentioned, I did not feel able to be quite positive of the relation of cause and effect, the number being so small, but now there seems some justification for an assumption that the iodine has enabled these animals of European parentage to overcome some defect in metabolism due to an inherited factor influencing growth and patent in the normal hot areas of India. In years past we have been seriously troubled by the condition and have weeded out quite large numbers of cows which failed to milk well because of it, so that suddenly to find our herds completely free seems of striking importance.

The case may possibly be of value to breeders in other tropical and sub-tropical regions where European breeds have been found not good doers. In our case we are more or less compelled to use such cattle as when healthy they give from two to four times as much milk as the native animals; we would otherwise be compelled to purchase.

# FEEDING IODINE TO YOUNG CALVES AT BANGALORE.

BY

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The havoc played by the deficiency of minerals in the food given to young animals has been the subject of serious study by eminent nutritionists throughout the world. That iodine plays a prominent part among these minerals has been established by numerous workers. A very full bibliography of the subject is given by Frank Ewart Corrie [1928]. Experiments are quoted in this pamphlet to show that under suitable conditions iodine feeding has resulted in great benefit to live-stock. It is generally understood that iodine exerts this beneficial effect when there is a shortage of this element in the food. Col. McCarrison [1927] has however shown that iodine feeding might be beneficial even when there is no shortage of the element. It acts then presumably as an antiseptic in the system. Whatever the nature of the action may be, there is no doubt about the great benefit that is obtainable. In the Imperial Institute of Animal Husbandry and Dairying at Bangalore there is at times a considerable amount of scouring amongst the calves. It was suggested by Mr. F. J. Warth, Physiological Chemist, that iodine might have a beneficial effect in this case. Accordingly the following experiment was undertaken by the writer under the kind initiative and guidance of Mr. Warth.

A bunch of calves numbering 24 was taken over. Whenever casualties occurred or calves were disposed of otherwise, fresh additions were made to make up the number. Great care was exercised in the selection of the calves. Twelve groups were taken with two in each group representing as far as possible the same breed, sex and age. The calves in each pair got the same quantity of feed. In every pair one calf received five c.c. of 0 8 per cent. of potassium iodide once a day in milk, and the other calf was kept as a control getting no potassium iodide with its milk. Calves over one and half months old received some extra concentrates, and in all such cases the two animals to be compared were rationed identically. The experiment was started on 13th May 1930 and was continued till 18th August 1930, and the results found are as follows :—

1. During the course of this experiment, the calves getting no potassium iodide suffered more from digestive troubles and two died from such causes. Whereas in the case of calves getting potassium iodide only one calf suffered from indi-

gestion and there was also one death and that was due to inflamed joints after nine days' ailment (rheumatism).

| Calf Nos. | Calves which were given potassium iodide | Calf Nos. | Calves kept as controls |
|---|---|---|---|
| 982 | The calf was dull and off feed on 20th May 1930, also the joints were inflamed. The calf was unable to get up, refused taking feed and died on 29th May 1930. | 978 | Suffered from diarrhœa from 1st July 1930 to 7th July 1930 and again suffered from diarrhœa from 25th July 1930 to 1st August 1930. |
| | | 982 | Suffered from dysentery from 17th July 1930 to 19th July 1930. |
| | | 961 | Calf died on 23rd May 1930 due to gastro-entritis. |
| | | 976 | Suffered from white scour from 3rd June 1930 to 13th June 1930. |
| 981 | Suffered from indigestion for two days, *i.e.*, on the 1st and 2nd August 1930. | 996 | Suffered from diarrhœa from 12th July 1930 to 15th July 1930, and again from 17th July 1930 to 20th July 1930. |
| | | 990 | Suffered from white scour from 13th June 1930 to 20th June 1930 and again from 1st July 1930 to 13th July 1930. |
| | | 983 | Showed symptoms of diarrhœa on 13th June 1930 and died on 15th June 1930. |

2. During the course of this experiment, it was also found that some of the calves suffered from mange and ringworm and their details are as given below :—

| Calf No. | Calves which were given potassium iodide | Calf Nos. | Calves kept as controls |
|---|---|---|---|
| Calf of Buffalo No. 14. | The calf was under treatment for a small patch of ringworm from 3rd June 1930 to 8th June 1930. | 982 | Got an attack of ringworm on 1st August 1930 and is still under treatment. |
| | | 991 | The calf is still under treatment for mange from 21st July 1930. |
| | | Calf of buffalo, No. 2. | The calf is still under treatment for mange from 23rd May 1930. |
| | | 976 | Suffered from mange from 16th July 1930 to 2nd August 1930. |
| | | 996 | The calf is still under treatment for ringworm from 1st August 1930. |

3. Another important observation made during the course of the experiment was that the calves which were given potassium iodide exhibited greater appetite for milk and consumed their share of milk much quicker and better than the controls.

4. In live weights no marked effect was noted.

5. Potassium iodide produced a marked effect on the appearance of the animals.

To obtain an independent judgment on this point Mr. A. A. Lamb, Superintendent of the Imperial Institute of Animal Husbandry and Dairying at Bangalore, was approached with a request to act as judge. The calves were all put in one pen and were shown to him in pairs with no distinguishing marks, and he selected those calves which were better-looking and glossy in appearance. Out of the twelve calves he selected, eleven had received potassium iodide, thus bearing testimony to the efficacy of potassium iodide feeding.

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# OBSERVATIONS ON THE CASTOR-OIL PLANT (*RICINUS COMMUNIS* LINN.) IN THE UNITED PROVINCES.*

BY

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## Introduction.

Cawnpore is the chief centre of the oil industry in the United Provinces, and a large quantity of oil-seed comes into its markets for crushing. Castor is one of the most important oil-seeds, and cartloads of it are seen coming from surrounding villages. A mere glance at the heaps of the castor seed, and a handful from any of them will show a mixture of twelve to twenty varieties in one lot, differing in their size, colour, and patterns on the shell. This seed is purchased by the mill-owners from year to year in a haphazard manner, regardless of the percentage of oil it contains, or without any measurement of the moisture content. No estimation is made of the amount of husk enclosing the kernel, which may be as high as 34 per cent. of the total weight of the seed. These factors raise or lower the value of the seed, and the oil millers run a great risk in purchasing seed of mixed types. In order to define these varying factors, and to bring to the notice of the cultivators and mill-owners the utility of growing and crushing pure types of such varieties, which contain high percentage of oil, and are useful economically, a large number of varieties of castor seed were collected from the province and elsewhere, and grown at the Botanical Research Farm, Cawnpore. Pure cultures of these types were isolated, and numerous analyses were made of them. It was also decided to record as much information as possible on the cultivation of this crop, as no experiments have been carried out so far in these provinces and little or no litérature existed on the subject. The first portion of this note is descriptive, and the second deals with the experiments designed to discover the most important direction of improvement of the oil percentage in the seed. The results so far obtained point to definite conclusions.

## Descriptive.

*Description and distribution of the plant.*—The plant is an evergreen shrub belonging to the natural order Euphorbiaceæ, and differing much in height and branching according to respective varieties. Their leaves are simple palmate usually green in colour. The stems are either red or green, or possess shades of either colour, and are usually covered with a white blossom. Flowers are unisexual, and both sexes are found on one raceme, the females at the top and the males at the base (Plate XXI, fig. 3). Both types of flowers mature at about the same time,

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the male flowers perhaps slightly earlier. The pollen is shed actively in the morning from 11 A.M. to 2 P.M. when the maximum temperature in December and January is 70° F. to 80° F. All the flowers, either male or female, of the same spike do not mature at the same time.

Castor is grown to a greater or less extent in every district of the province, but usually as a field border, and very rarely as a sole crop. The only division, in which the area it covers is large enough to deserve mention, is Allahabad where it is reported to cover about 1,400 acres along the margin of the river Jumna. It is very commonly grown on isolated patches in the neighbourhood of dwelling houses, and used as a support for the creeping bean known as *sem* (*Doilchos lablab*). It also grows wild in different localities in the province, more commonly near villages, on the manure pits and in deserted shallow ditches, where the blown seed finds a favourable situation for germination.

*Cultivation (as practised).*—It is chiefly cultivated along the top of the high mud banks, which commonly surround orchards and vegetable gardens. It serves there the double purpose—as a protection to the field and as a support to the bean creeper. In certain districts, it may be sown as a mixed crop with *arhar* (*Cajanus indicus*), *chari* (*Sorghum*), bean, etc. The writer has not come across any field, in these provinces, sown with castor only. It is doubtful if growing castor as a single crop in a field would be as profitable as growing it on border or as a mixed crop. Probably in both these latter conditions it gets more aeration. It was experienced on the farm that a pure variety grown as a sole crop on an acre basis almost always developed a disease of one kind or other. The United States of America, in order to produce all the oil required for their industrial purpose, covered in 1918 about 200,000 acres of land in the Southern States with the castor-oil plant. The trial ended in a failure, as the crop was badly attacked by a fungoid disease—a species of *Botrytis*—which attacked and spoiled the racemes at the early stage of their growth. The amount of damage caused by this disease reached about 90 per cent. of the fruiting racemes, and further attempts to grow the crop were given up. It seems thus that the present method of growing on elevated banks (*bunds*), or as a mixed crop as practised by the cultivators, is based on experience, and is not without its intrinsic advantages.

The plant is generally sown in sandy soils, but it thrives best in rich loams. It does not grow well in clay. It is a drought-resistant plant, but is very susceptible to water during the early stages of its growth. It is because of this that it does remarkably well on ridges and boundaries of fields. It is usually sown in June or July at the commencement of the monsoon or with canal irrigation just before the rains break. The young plants are usually earthed up round the bottom of the

stem to prevent the accumulation of water. Usually no winter variety is sown in October in these provinces. It is ready for harvest in March-April. Mature fruits begin to appear about the end of February. The racemes are gathered in April once every week, either being pulled off by hand, or cut with a knife just when they split and shed their seed. These capsules, a majority of which are still green, are put in a pit covered with cow-dung and earth for separating the seed from the capsules. They are then taken out after three or four days, dried in the sun and sold in the market. In the perennial varieties, the yield in the first year is less than that in the succeeding years, and the net result remains profitable for about 3 to 4 years, and then gradually decreases.

*Cultivation* (*per acre*).—We now come to an important aspect of the subject—cultivation per acre—as it is not sown anywhere in these provinces as a single crop. The various agricultural operations, and approximate expenses given below, of raising an acre of castor-oil plant, and rate of different commodities in the market, would be useful for cultivators and zemindars who are interested in its cultivation and want to sow it on a large scale.

The land is ploughed twice and brought into a fine state of tilth with the first fall of the rain in June, or with the canal water before the rains. Good selected seeds are sown in lines four feet apart, at the rate of 10 seers per acre after the plough, and 5 seers by dibbling. With closer sowings the plants grow tall and are difficult to pluck. Moreover by crowding together they do not get enough light and air, and are liable to develop diseases. If the germination is weak which is often due to heavy rains, the gaps are filled in by dibbling in the seed by hand. When the plants are six to nine inches above the ground, they are thinned by removing the weaklings. Two to three such thinnings are required before the plants are four feet apart each way. In ordinary circumstances it requires one or two irrigations, if it happens to be dry and the monsoon stops early. The fields may be hand-weeded twice or thrice during growth. The crop is ready for harvest in March-April. The crop remains in the field for about ten and a half months in the year, and if it is not attacked by any disease, gives approximately ten maunds of the seed per acre. In the second year, the stems are cut, and the land is cleaned of weeds, and watered. This is done immediately after the harvest, in order to save the old roots from the attacks of the white ants.

*Manure.*—If farmyard manure is available, it may be applied in the beginning at the rate of seven or eight cartloads (each fifteen to twenty maunds) per acre, with the first ploughing, and thoroughly incorporated with the soil. If it is not available then a piece of land which had previously grown a leguminous crop should be selected for growing castor. Castor exhausts the soil soon, and cow-dung manure should be applied every year.

***Estimates per acre.***—No estimate can be given which will hold good for all the places within the province. A few varieties were grown successively for two years on acre pieces at the Botanical Research Farm, Cawnpore (Plate XX). The approximate estimates of cost and profit are shown in Table I. These are also compared with conditions prevailing in rural areas. It is profitable to grow only one variety for two years at one time. In the third year the crop must be removed, as the roots become hollow from inside, and the yield becomes poor. A cultivator can save some items of expenses on labour, as shown in Table I, by growing bean creeper with castor.

TABLE I.

*Showing approximate expenditure on, and profit from, an acre of land sown with castor alone.*

| Details of operations | EXPENDITURE IN THE CITY ON ONE ACRE OF LAND | | | | EXPENDITURE IN A VILLAGE ON ONE ACRE OF LAND | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| | 1927 | | 1928 | | 1927 | | 1928 | | |
| | Lift irrigation | Flush irrigation | Lift irrigation | Flush irrigation | Lift irrigation | Flush irrigation | Lift irrigation | Flush irrigation | |
| | Rs. As. | Rs. As. | Rs. As. | Rs. As | Rs. As | Rs. As. | Rs. As. | Rs. As. | |
| 1. A. T turn-wrest plough, with '*Pahta*'. | 3 0 | 3 0 | ... | ... | 3 0 | 3 0 | ... | | First day |
| 2 Manure | 6 0 | 6 0 | 6 0 | 6 0 | 6 0 | 6 0 | 6 0 | 6 0 | 100 maunds per acre. |
| 3. Cartage and spreading charges of manure. | 4 0 | 4 0 | 4 0 | 4 0 | 4 0 | 4 0 | 4 0 | 4 0 | |
| 4. '*Desi*' plough with '*Pahta*'. | 2 0 | 2 0 | ... | ... | 2 0 | 2 0 | | ... | Second day. |
| 5. Sowing (Dibbling). | 2 4 | 2 4 | ... | ... | 1 8 | 1 8 | ... | .. | Six men at As. 6 in the city and As. 4 in the village |
| 6. Weeding and thinning. | 7 12 | 7 12 | 7 12 | 7 12 | 7 12 | 7 12 | 7 12 | 7 12 | Two times 24 men. |
| 7. Irrigation | 4 8 | 0 12 | 4 8 | 0 12 | 3 0 | 0 12 | 3 0 | 0 12 | Two times 6 men each time. |
| 8. Canal dues. | 3 0 | 3 0 | 3 0 | 3 0 | 3 0 | 3 0 | 3 0 | 3 0 | |
| 9 Land rent | 10 0 | 10 0 | 10 0 | 10 0 | 7 0 | 7 0 | 7 0 | 7 0 | |
| 10. Seed | 0 11 | 0 11 | | . | 0 11 | 0 11 | ... | ... | |
| 11 Harvesting | 3 0 | 3 0 | 3 0 | 3 0 | 2 0 | 2 0 | 2 0 | 2 0 | Eight men at As 6 each |
| 12. Cleaning seed. | 3 0 | 3 0 | 3 0 | 3 0 | 2 4 | 2 4 | 2 4 | 2 4 | Twelve women at As. 4 each. |
| Total expenditure. | 49 3 | 45 7 | 41 4 | 37 8 | 42 3 | 39 15 | 35 0 | 32 12 | |

| | Income per acre in the city | | Income per acre in the village | | |
|---|---|---|---|---|---|
| | 1927 | 1928 | 1927 | 1928 | |
| | Rs. | Rs. | Rs. | Rs. | |
| 1. Seed (10 mds.) | 57 | 57 | 54 | 54 | At 7 seers per rupee. |
| 2. Wood (about 2,500 sticks). | 20 | 20 | 10 | 10 | At As. 12 a hundred. |
| Total income | 77 | 77 | 64 | 64 | |

*Diseases.*—The following pests commonly attack the crop in these provinces :—

(1) *Dichocrocis punctiferalis.*—It is a stem-borer and seed-eating caterpillar. It generally bores into the first flower-head growing between the two branches, proceeding upwards until it spoils the whole raceme. The caterpillar also bores into the young capsules, and eats away the developing seeds. The only remedy consists of picking off the attacked fruits and burning or burying them.

(2) Leaf sucking castor, mealy bug, known as *Aleurodes ricini.* Its young ones suck the sap out of the leaves. If the attack is limited to a few plants, the infested leaves may be removed and buried or burnt or sprayed with crude oil emulsion. On the excreta and dead bodies of these insects, various kinds of saprophytic fungi grow up. These fungi, though they appear to be, are in fact not the direct cause of the trouble.

(3) *Botrytis.*—A species of this also commonly attacks the plant, and spoils the fruiting racemes at the early stage of their growth.

It is interesting to note that the plants are attacked mostly when grown as a sole crop on a field scale. It escapes the attack, when sown in single lines or as a mixed crop. A similar phenomenon happened in America, as described before, when it was cultivated on a large scale as single crop. The crop was badly attacked, and it resulted in total failure. What is this due to—crowding together, absence of light, or air—is not quite clear yet. This matter is being further investigated.

*Trade figures and market rates.*—Table II shows the annual output of this crop in these provinces and the comparative figures of export and import of seed and oil. More than one-fifth of the seed produced and imported annually to these provinces is exported to Calcutta and other ports. The oil is chiefly consigned to Punjab, Rajputana, Bengal and Bihar. The largest buyers of castor oil in the province are undoubtedly the Railways, some of which have their own oil mills (*e.g.*, one of E. I. R. at Manauri, near Allahabad).

TABLE II.

*Comparative figures of average annual production, export and import of castor seed and oil in the United Provinces.* [*Duke, 1926.*]

| Article | Harvested Mds. | Value in Rupees | Export Mds. | Value in Rupees | Import Mds. | Value in Rupees |
|---|---|---|---|---|---|---|
| Seed . . | 600,000 | 42,00 000 | 117,585 | 8,23,095 | 88,444 | 6,19 108 |
| Oil . . . . . | ... | | 31,941 | 8,30,466 | 13,586 | 3,53,236 |

The seed is sold at the rate of six to seven seers per rupee in the Cawnpore market for crushing. The material brought by the cultivators contains about two seers of empty shells and capsules in a maund of seed.

Three important types of crushers are employed for extracting the oil: one is the hand press, the second the hydraulic, and the third the expeller. The hand press, though not power driven, is considered to be better than the other two, and many mills are equipped with hand power screw presses. Castor has a husk, which varies in quantity from 26 to 34 per cent. of the weight of the seed. By the removal of this husk, which contains no oil, the capacity of mill can be increased by 26 to 34 per cent. A great saving on coal, wages and wear and tear of the rollers can also be effected. In the hand press the seed is first crushed, and about eight to ten seers of husk obtained per maund is removed, and the remaining thirty to thirty-two seers are used for pressing oil. This is wrapped up in gunny pieces, and pressed in between iron plates over fire (Plate XIX). About 37½ to 40 per cent. of oil is extracted in this way, depending on the quality of the seed. Thus, one maund of seed gives about sixteen seers of oil. In the other two presses, no cleaning is done, and shells and rubbish is all pressed together, and the oil percentage is slightly higher (40 per cent.). The colour of the decorticated castor seed oil, extracted from the hand press, is better and fetches one to three rupees per maund more in the market. The cake also, of the hand press, is cleaner and fetches better price (rupees three to rupees three and annas eight per maund) as compared to the cake produced by the power driven presses. The latter is darker in colour, is inferior in oil percentage, and sells at cheaper rate (rupees two and annas two per maund). One hand press working nine hours a day with three men for six turns (about an hour and a half each turn) will produce four to four and a half maunds of oil, and the same quantity of cake. In Egypt, as Gadalla [1924-25] reports, the oil is extracted by washing the seed with hot water instead of pressing. In this process the seed is roasted like coffee beans, ground into coarse grains and boiled in water. The oil floats to the surface of the water. It is skimmed off, boiled again in another vessel, skimmed again, and kept in glass vessels for use. Most of

the castor oil made in the province is of very poor quality, being too acid, and the colour is too dark to fetch a high price. According to Duke [1926], more attention should be given to the storage of seed in dry godowns, since the oil extracted out of wet seed rapidly becomes acid.

The Indian beans are quite superior, and, according to White [1918], of the millions or more bushels of beans imported into U. S. A. through the port of New York, the bulk comes from Madras and Bombay, and according to him, the oil-content of Indian beans runs as high as 55 per cent. as compared to Zanzibar beans which give only 35 per cent. oil, and is of inferior quality, because of the increased amount of acid.

Samples of castor seed were collected from the United Provinces, and Madras, Guntur, Hyderabad (Deccan), Ahmedabad and Bombay, in order to see the difference of oil percentage between the local and outside varieties. The result is shown in Table III. We find that the indigenous varieties are in no way inferior to those from other provinces, and fairly good material already exists in these provinces for propagation.

TABLE III.

*Analyses of foreign (F) and indigenous (I) samples of castor seed, sown 1923.*

| No. | | Percentage of shell | Percentage of moisture in dry kernel | Percentage of oil in dry kernel | Percentage of oil in whole dry seed |
|---|---|---|---|---|---|
| | *Seed obtained from outside the province.* | | | | |
| 1. F | From Guntur . . . . . | 32·20 | 3·28 | 70·84 | 48·04 |
| 2. F | Hyderabad best variety . . . | 33·47 | 3·28 | 67·70 | 45·04 |
| 3. F | Big castor spiny, Madras . . | 26·98 | 4·28 | 68·58 | 50·07 |
| 4. F | Big castor spineless, Madras . . | 23·82 | 3·95 | 68·74 | 52·36 |
| 5. F | Small castor, Bombay . . . | 31·92 | 4·79 | 66·76 | 45·44 |
| 6. F | Small seeded variety, Bombay. . | 24·52 | 4·52 | 68·11 | 51·39 |
| 7. F | Big seeded variety, Bombay . . | 23·96 | 4·46 | 69·23 | 52·64 |
| 8. F | Harij, Gujarat . . . . . | 31·04 | 4·17 | 68·01 | 46·91 |
| 9. F | Patan, Gujarat . . . . . | 33·42 | 2·86 | 70·79 | 47·11 |
| 10. F | Porbander, Kathiawar . . . | 31·20 | 2·82 | 71·93 | 49·50 |
| 11. F | Vadal, Kathiawar . . . . | 28·58 | 4·32 | 70·13 | 50·09 |

| No. | | Percentage of shell | Percentage of moisture in dry kernel | Percentage of oil in dry kernel | Percentage of oil in whole dry seed |
|---|---|---|---|---|---|
| 12. F | Ralli Brothers, Madras . . . | 29·02 | 3·86 | 69·95 | 49·65 |
| 13. F | Louis Dreyfus & Co., Bombay and Solkart Bros. | 27·26 | 5·46 | 72·02 | 52·38 |
| 14. F | | 28·60 | 5·52 | 70·17 | 50·1 |
| 15. F | | 28·36 | 5·31 | 72·93 | 52·23 |
| 16. F | | 28·52 | 5·52 | 73·02 | 52·18 |
| 17. F | | 27·60 | 5·88 | 74·94 | 54·25 |
| 18. F | | 28·84 | 6·04 | 74·50 | 53·03 |
| 19. F | | 28·64 | 6·46 | 73·82 | 52·69 |

*Indigenous castor seed of the United Provinces.*

| | | | | | |
|---|---|---|---|---|---|
| 1. I | Raya (Muttra) . . . . . | 30·52 | 2·64 | .. | 51·36 |
| 2. I | Do. . . . . . | 24·72 | 3·28 | .. | 47·52 |
| 3. I | Red good early, E. B.'s Farm, Cawnpore. | 33·00 | 2·55 | .. | 47·42 |
| 4. I | Red good early branching . | 31·42 | 2·99 | .. | 45·25 |
| 5. I | Red good late . . . . . | 27·58 | 2·57 | .. | 53·79 |
| 6. I | Red good late branching . . | 30·16 | 2·86 | .. | 47·25 |
| 7. I | Inter good early . . . . . | 31·10 | 2·95 | .. | 47·68 |
| 8. I | Inter good late . . . . . | 28·09 | 2·50 | .. | 54·04 |
| 9. I | Green good early . . . . . | 26·05 | 2·86 | 74·27 | 54·92 |
| 10. I | Green good late . . . . . | 26·79 | 2·82 | 77·02 | 56·36 |
| 11. I | Small castor, Orai . . . . . | 27·82 | 5·34 | 67·53 | 49·42 |
| 12. I | Large castor, Orai . . . . . | 27·52 | 5·05 | 66·31 | 48·06 |
| 13. I | Chitakwa castor, Atarra . . | 30·50 | 5·52 | 68·13 | 47·36 |
| 14. I | Bhatakwa castor, Atarra . . | 27·24 | 5·50 | 66·36 | 48·27 |

Out of all the varieties, No. 10 I, an indigenous variety, gives the highest percentage of oil (56·36 per cent.), and the other two varieties, 8 I and 9 I, giving 54·04 and 54·92 per cent. of oil also belong to these provinces. It would be obvious that a mill crushing the above varieties would have far greater margin of profit over the one crushing varieties like 8 F, 9 F. or 13 I.

*The economic utility of the plant.*—The merit of castor oil over other oils is credited to its great viscosity due to its hydroxylated condition. This merit has given it a great importance in lubricating railway engines, aeroplanes and other minutely constructed machines. It is, as already pointed out, extensively employed by railways in India and is also used in many industries, *e.g.*, manufacturing artificial leather, preparing artificial rubber, in the manufacture of soaps, adhesive cements, dyes, skin-creams, copying-inks, etc. It is also an important household remedy, and everybody knows the utility of castor oil as a purgative. The leaves of the plant are used in feeding the Eri silkworm *Attacus Ricini*, and the stems of some of its varieties are said to contain fine fibres, which may be used in weaving coarse fabrics or in making ropes. At present they are used for thatching and as fuel. The silkworm feeds exclusively on castor leaves, and produces a cocoon known as Eri silk. The industry is capable of wide extension in these provinces, as a cottage industry, wherever castor grows abundantly. The cultivation of Eri silk can be carried on from the beginning of July, as soon as the monsoon breaks out, to the end of February. It cannot be grown when hot and dry winds begin to blow.

Large quantities of castor oil were at one time exported from the United Provinces, as from other parts of India, but owing to the inferior quality of the indigenous oil, more oil-seed than oil has been exported since 1890, except during the war. It is likely that the demand for the latter will increase in the foreign countries, owing to the greater requirement for engine lubrication. That the demand in India of vegetable oils will tend to increase rather than decrease, may be judged by what has occurred in other countries, namely, that as the wealth and standard of living has increased, the consumption of oils has risen accordingly. As India develops in manufacturing industries, the demand of oil for all kinds will certainly increase. There is also a great demand for castor cake for manurial purpose in these provinces. This demand is increasing rapidly, with the increase of cultivation of sugarcane, for which it is particularly suitable.

## Experimental.

Valuable varieties were collected from Messrs. Volkart Brothers and other sources, and from different localities of these provinces. These were sown in single rows at the Botanical Research Farm, Cawnpore. A detailed study of these rows showed clear difference among the plants of each family and between them

and those of other families in many cases in respect of vegetative characters such as branching, presence of red and green colour on the stems, size of the seed, and dehiscence of fruits at maturity. None of those types could be considered as a botanical variety. Selections were made by selfing, and pure seed was produced from individual plants, which were true representatives of a type. Selfing was done in the progeny successively for four years, until each variety was pure and fixed, and did not show any trace of a hybrid plant. The inflorescences were covered with light paper bags in the beginning, and thin muslin sacks afterwards, to produce pure selfed seed. The change of paper bags to muslin sacks was necessary to keep the rapidly lengthening inflorescence covered for a considerable period until all danger of contamination was eliminated. The bags were generally shaken once every morning, as the flowers usually open in morning hours (10 A.M. to 2 P.M.), in order to ensure the pollens to reach the sticky stigmas near the top of the spike. According to White [1918], cross-fertilization takes place only to the extent of about five per cent. and the selfing period for fixing a variety should not exceed five years. This pure seed was multiplied, and the results shown in the following tables are obtained from analysis of these seeds.

To make commercial castor-oil bean growing in this country a permanent industry, requires the breeding of varieties having close compact fruiting spikes with non-dehiscent seed capsules. The plants should of course be prolific and early maturing. The material for producing such varietal types already exists among the many forms available in these provinces; the main problem is to bring them together into one or more commercial varieties. Before we could set our heart to solve this problem, a preliminary investigation into the changes of oil percentages in different morphological forms of the plant, and under varying conditions of growth, was necessary. The work detailed below in the following tables shows the variation of oil percentage under different conditions. The knowledge of oil percentage is the most important factor, as, according to Duke [1926], an average improvement of even one per cent. in the oil-content of the oil-seeds grown in the United Provinces, alone, would represent an increased value of at least Rs. 15,00,000 per annum.

*Method of analysis.*—The method in this analysis was that of extraction of the dried seed, with either ether or chloroform, 10 grammes of kernel being taken and extracted in a Soxhlet apparatus for three hours. After this time the ground kernels were again re-ground, and the extraction continued for another two hours. The solvent was then evaporated off and recovered until the oil was free from smell of solvent by means of a Bunsen burner and low flame. The oil was then placed in an air oven for three hours at 105°C. to 108°C., and the weight taken.

This method naturally shows a higher percentage of oil than could possibly be obtained by the oil presses used in the mills. The percentage of oil was calculated on the dry matter of the kernels. The percentage of oil on the whole dry seed would have been slightly higher, had the moisture in the shells been taken into consideration. An examination of the figures shows that the percentage of oil in the dry kernels varies from 65·98 to 77·02 and in the dry seed from 45·25 to 56·36.

### 1. *Manurial Experiments.*

Three varieties were sown and treated with different manures successively for three years. The application of manures resulted in an increase in the yield of seed and variations in the percentage of their oil content. The following table will make this clear :—

TABLE IV.

*Showing the effect of different manures on yield and oil percentage in the seed.*

| | Year | Reference number | Cow-dung | Amonium sulphate | Castor cake | Neem cake. (*Azadirachta indica*) | Muriate of potash | Superphosphate | Un-manured |
|---|---|---|---|---|---|---|---|---|---|
| Yield of average twenty plants (lb.). | 1927 | A. 1 | 15/10 | 13/6 | 13/3 | 12/4 | 11/6 | 9/10 | 5/12 |
| | 1928 | C. 23 | 14/8 | 13/9 | 12/10 | 13/6 | 12/2 | 10/4 | 6/8 |
| | | C. 27 | 15/3 | 14/4 | 14/2 | 12/6 | 11/0 | 7/8 | 8/5 |
| | 1929 | C. 23 (Crop | 13/7 diseased) | 10/12 | 11/9 | 14/6 | 10/9 | 8/7 | 5/9 |
| | | C. 27 | 14/10 | 13/9 | 14/8 | 12/7 | 12/6 | 9/12 | 9/3 |
| Oil percentage in the whole dry seed. | 1927 | A. 1 | 52·9 | 52·6 | 58·0 | 56·8 | 53 | 46·8 | 52·4 |
| | 1928 | C. 23 | 48·55 | 50·76 | 51·86 | 52·28 | 49·56 | 47·82 | 50·62 |
| | | C. 27 | 53·22 | 52·84 | 50·89 | 54·18 | 52·38 | 53·35 | 51·77 |
| | 1929 | C. 23 (Crop | 48·63 diseased) | 48·45 | 44·70 | 48·44 | 47·51 | 42·38 | 41·69 |
| | | C. 27 | 51·57 | 50·40 | 50·91 | 57·38 | 51·47 | 56·23 | 49·03 |

Cow-dung application produces maximum yield in almost all cases. It seems to suit best for increasing yield, and the vegetative growth of the plant. Other nitrogenous manures also increase the yield to a considerable extent. Superphosphate and muriate of potash do better than the absence of any manure. As regards the oil percentage, all the three varieties seem to show an increase in their oil percentages with the application of *neem* cake. It is a useful and interesting result, as few experiments already conducted in this direction by Mr. M. N. Ghosh [ 1924 ] showed that the percentage of oil did not vary and remained constant, with the application of different manures. Mr. Ghosh did not use *neem* cake in the manurial trials. Although an increase or decrease of the oil percentage, as will be seen later, depends largely on the ripe or the immature condition of the seed, but since all the varieties showed an increase with *neem* cake, its application seems to have some effect in raising the oil percentage. In order to confirm these results, further trials of similar nature are in progress. The application of *neem* cake is also useful in warding off the attacks of the white ants and other diseases.

### 2. *Big and small seed varieties compared.*

All degrees of intergrades in size of beans existed in the original collection, these no doubt resulting from more or less chance crossing which wind and insects have brought about during centuries of its cultivation. The progeny of pure selfed seed of typically big and small seed varieties (Plate XXII, fig. 1) was selected for analysis and the results are shown in Table V.

TABLE V.

*Showing difference in percentage of oil in the whole dry seed of big and small seeded varieties.*

| Reference Nos. | 1927 | 1928 | 1929 |
|---|---|---|---|
| A 6 (Big red) | 52·1 | 48·05 | 46·47 |
| A 6 (Big green) | 52·5 | 47·56 | 50·74 |
| a 14 (Small red) | 54·5 | 53·32 | 58·01 |
| a 11 (Small green) | 53·8 | 40·10 | 58·69 |
| C 23 (Big seed) | .. | .. | 50·30 |
| C 25 (Small seed) | .. | .. | 51·60 |
| C 27 (Big seed) | .. | .. | 45·34 |
| Market (Small red) | .. | .. | 55·43 |
| „ (Big red) | .. | .. | 48·34 |

The market varieties were also tested and it was invariably found that the small-sized seed showed better percentage of oil than the big-sized seed. The endospermic material is always more compact in the small seeds than in the big ones. In the latter it is comparatively loose and has a greater hollow space between the two halves of the kernel. The high yield of oil in the small seed is thus probably due to greater compactness of endosperm within the shell.

3. *Comparison of central and side branches of the plant.*

Generally there are two types of branching in the castor-oil plant. One is the ordinary type with a central shoot and side branches springing from near the base (Plate XXIII, fig. 1) and the second branching near the top only with central and side spikes (Plate XXIII, fig. 2). Seeds were collected from the central shoot in both cases, and compared with the seed of their respective side branches, to see the difference in the oil percentages. Table VI shows the result of plants having basal branching, while Table VII shows the result of top branching plants.

TABLE VI.

*Showing difference in oil percentage in seed of a central and a side branch of basal branched plants.*

| Reference No. | Year | |
|---|---|---|
| | 1927 | 1929 |
| C 14 (central) . . . . . . . . . . . . | 52·6 | 53·2 |
| „ (side) . . . . . . . . . . . . | 51·2 | 51 8 |
| A 6 (1) (central) . . . . . . . . . . . | 55·6 | 55·78 |
| „ (side) . . . . . . . . . . . . | 47·2 | 47·34 |
| C 15 (central) . . . . . . . . . . . . | 54·4 | .. |
| „ (side) . . . . . . . . . . . | 49·2 | .. |
| C 23 (central) . . . . . . . . . . . . | .. | 35·84 |
| „ (side) . . . . . . . . . . . . | .. | 33·75 |
| C 27 (central) . . . . . . . . . . . . | .. | 40·0 |
| „ (side) . . . . . . . . . . . . | .. | 39·67 |
| a 22 (central) . . . . . . . . . . . . | .. | 53 78 |
| „ (side) . . . . . . . . . . . . | .. | 47·83 |
| A 6 (central) . . . . . . . . . . . . | .. | 55·03 |
| „ (side) . . . . . . . . . . . . | .. | 46·46 |

The central shoot invariably shows a greater percentage of oil. The central branch develops a bigger sized raceme, and bears a greater number of capsules. It generally ripens earlier than the side branches, and, as will be seen later, early maturity has also some effect in increasing the oil-content of its seed. A similar phenomenon is seen in branches of a top branched plant. It generally develops three racemes near the head, one central and two side ones. The central is the longest, and has got the largest number of capsules on it. It also ripens earlier than the other two.

TABLE VII.

*Showing difference in oil percentage in seed of a central and a side shoot of top branched plants.*

| Reference No. | Year | |
|---|---|---|
| | 1927 | 1928 |
| a 22 (central) | 54·4 | 51·31 |
| ,, (side) | 50·3 | 53·23 |
| C 14 (central) | 52·57 | 49·83 |
| ,, (side) | 51·95 | 52·47 |
| C 23 (central) | .. | 50·00 |
| ,, (Side) | .. | 44·29 |
| C 25 (central) | .. | 51·60 |
| ,, (Side) | .. | 50·03 |
| a 6 (central) | .. | 54·54 |
| ,, (side) | .. | 40·71 |
| C 28 (central) | .. | 52·88 |
| ,, (side) | .. | 55·29 |

The majority show better percentage of oil in the central shoot, but a few types, *e.g.*, Nos. a 22 and C 14, show greater percentage in the side shoot. This may have been due to difference in maturity of seed of the central and the side shoot, which may have been collected at different times.

### 4. *Mature and green seed compared.*

The oil-content of castor seeds depends more upon the degree of maturity than on any thing else. This is apparent from the results shown in the Table VIII.

TABLE VIII.

*Showing difference in oil percentage in mature and green seed.*

| Reference No. | 1928 | | 1929 | |
|---|---|---|---|---|
| | Oil percentage | Difference in favour of mature | Oil percentage | Difference in favour of mature |
| 1 F mature | 50·40 | 7·43 | .. | .. |
| „ green | 42·97 | | | |
| 2 F mature | 51·42 | 9·54 | .. | .. |
| „ green | 41·88 | | | |
| 9 I mature | 54·95 | 3·15 | .. | .. |
| „ green | 51·80 | | | |
| 10 I mature | 54·26 | 2·10 | .. | .. |
| „ green | 52·16 | | | |
| A 1 mature | 52·4 | 3·0 | .. | .. |
| „ green | 49·4 | | | |
| C 23 mature | .. | .. | 50·30 | 4·63 |
| „ green | .. | .. | 45·67 | |
| C 4 mature | .. | .. | 51·72 | 7 36 |
| „ green | .. | .. | 44·36 | |
| a 11 mature | .. | .. | 52·89 | 9·34 |
| „ green | .. | .. | 43·55 | |
| C 28 mature | .. | .. | 52·40 | 0·86 |
| „ green | .. | .. | 51·54 | |
| Market red— mature | .. | .. | 55·43 | 8·08 |
| green | .. | .. | 47·35 | |

The difference ranges from 0·86 to 9·54, depending on the quality of the seed and the degree of maturity. In some cases the seeds of matured capsules show a fairly large difference of oil percentage as compared to the unripe ones. Even a slight difference in maturity of seeds from the same head seems to have a considerable effect on their oil percentages. This shows the importance of

harvesting only the ripe capsules. The usual method of harvesting employed by the cultivators of these provinces consists of removing the heads, when only a few of the top seeds have ripened, the rest of the seed attaining maturity slowly after keeping. In order to escape losses of seed, which happens in dehiscent varieties, the cultivator gathers young shoots, and thereby loses a fair percentage of oil. This method is obviously very faulty, and should be stopped. The practice of gathering unripe capsules can also be avoided by growing only non-dehiscent varieties.

*5. Seeds from dehiscent and non-dehiscent capsules compared.*

In some varieties the capsules burst no sooner than it is ripe or is about to ripen. In this the seed gets scattered, and is difficult to gather in the end and is lost. The non-dehiscent types do not burst on ripening and are therefore a great advantage to the cultivator (Plate XXI, fig. 2). Analysis of seeds from both these types was made to find out if any difference existed in their oil percentages. The results are shown in Table IX.

TABLE IX.

*Showing difference in oil percentage in dehiscent and non-dehiscent varieties.*

| Reference No. | 1927 | 1928 | 1929 | Percentage of moisture in the kernel |
|---|---|---|---|---|
| C 14 (D) . . . . . . . | 55·6 | 53·08 | 53·2 | 5·7 |
| C 23 (Non-D) . . . . . . . | 54·5 | 55·11 | 42·56 | 4·8 |
| A 4 (D) . . . . . . . | 50·3 | 47·79 | 47·37 | 5 2 |
| a 22 (Non-D) . . . . . . . | 54·0 | 50·78 | 53·78 | 4·5 |
| C 27 (Non-D) . . . . . . | .. | .. | 45·34 | 4·53 |
| 1 Market red (D) . . . . . . | .. | .. | 48·75 | 5·36 |
| 2 ,, ,, (D) . . . . . | .. | .. | 43·20 | 5 60 |
| C 4 (Non-D) . . . . . . . | .. | .. | 36·10 | 4·54 |
| 3 Market red (D) . . . . . . | . | .. | 49·75 | 6·09 |
| A 1 (Non-D) . . . . . . . | .. | .. | 39·40 | 6·40 |
| a 11 (Non-D) . . . . . . . | .. | .. | 58·69 | 5·09 |
| Green Market (D) . . . . . . | .. | .. | 50·02 | 5·32 |
| 4. Red market (D) . . . . . . | .. | .. | 55 43 | 4·97 |
| A 6 (Non-D) . . . . . . . | .. | .. | 54·55 | 4·63 |

D = Dehiscent.

No definite conclusions can be formed of the above results, as both types show greater or less percentage of oil in them. Such character as indehiscence, when combined with other useful characters, should be specially valuable in a variety grown for oil, since a large percentage of seed is not wasted by dehiscing of the mature capsules; labour is also saved, since it is not necessary to harvest the crop once or twice a week in order to avoid loss as in the case with the common dehiscent varieties. According to White [1918], this character is also easily transferable, as apparently not more than two pairs of factors are involved.

It is interesting to know that dehiscence probably takes place, because of more moisture in the kernel, as is obvious from the above results in the Table IX. Except for one type A 1 (non-dehiscent), where the percentage of moisture is fairly high, all the non-dehiscent types have comparatively lower percentage of moisture in their kernels. The point is interesting and, for confirmation, is being further investigated.

*6. Difference in oil percentage of green and red stemmed varieties.*

Seeds were also taken from the mature capsules of both such types, and were analysed for comparison. The results are shown in Table X.

TABLE X.

*Showing difference in the oil percentage of seed from green and red stemmed varieties (1929).*

| Reference No. | Percentage of moisture in seed | Percentage of kernel in seed | Percentage of shell in seed | Percentage of oil in whole seed | Percentage of oil in kernel |
|---|---|---|---|---|---|
| Green stem— | | | | | |
| A 6 . . . . . | 4·26 | 73.45 | 22·29 | 55·78 | 75·95 |
| C 27 . . . . | 4·53 | 73·22 | 22·25 | 45·34 | 61·93 |
| C 27 . . . . . | 5 33 | 72·17 | 22·50 | 49·79 | 69 01 |
| a 11 . . . . . | 5·09 | 70·50 | 24·41 | 58·69 | 83 26 |
| a 22 . . . . . | 5·15 | 70·51 | 24·34 | 53·16 | 75 39 |
| C 25 . . . . . | 5·27 | 68·64 | 26·09 | 51·60 | 75·18 |
| Red stem— | | | | | |
| C 23 . . . . . | 4·94 | 69·18 | 25·88 | 50·00 | 72·28 |
| C 4 (1) . . . . | 4·54 | 67·10 | 28·36 | 36·10 | 53·80 |
| A 1 . . . . . | 5·83 | 68·91 | 25·26 | 48·94 | 71 01 |
| a 14 . . . . . | 4·93 | 72·53 | 22·54 | 58·01 | 79·98 |
| C 14 . . . . . | 4·11 | 71·55 | 24·34 | 49·83 | 79·65 |
| C 4 . . . . . | 5 93 | 65·38 | 28·69 | 51·72 | 69·12 |
| A 6 (1) light purple . . | 5 32 | 67·72 | 26·96 | 53·70 | 79·30 |
| A 6 (2) yellow purple . . | 5·76 | 67·53 | 26·71 | 47·60 | 70·49 |

No definite result in favour of a particular colour is noticeable. Low and high percentages of oil are present in both colours.

*7. Comparison of seeds from spiny and smooth-walled capsules.*

This is a morphological difference of fruits in the castor-oil plant (Plate XXI, fig. 1). Seeds from both types of capsules were taken and analysed to see the difference in their oil-content. The results are shown in Table XI.

TABLE XI.

*Showing difference in oil percentage in smooth and spiny-walled capsules (1929).*

| Reference No. | Percentage of moisture in the seed | Percentage of kernel in the seed | Percentage of shell in the seed | Percentage of oil in whole seed | Percentage of oil in kernel |
|---|---|---|---|---|---|
| Smooth-walled capsule— | | | | | |
| 1. C 23 (lot) . . . | 6·93 | 58·36 | 34·71 | 40·52 | 69·44 |
| 2. C 23 (bed) . . . | 6·51 | 72·02 | 21·47 | 44·85 | 62·29 |
| 3. C 27 . . . . | 6·45 | 69·03 | 24·52 | 39·71 | 57·53 |
| 4. A 1 . . . . | 5·83 | 68·91 | 25·26 | 48·94 | 71·01 |
| 5. A 1 (1) . . . | 5·76 | 69·75 | 24·49 | 52·48 | 75·25 |
| 6. A 1 (2) . . . | 5·96 | 67·10 | 26·94 | 51·36 | 76·54 |
| Spiny-walled capsule— | | | | | |
| a 11 . . . . . | 5·09 | 70·50 | 24·41 | 58·69 | 83·26 |
| C 4 . . . . . . | 4·54 | 67·10 | 28·36 | 36·10 | 53·80 |
| a 14 . . . . . | 4·93 | 72·53 | 22·54 | 58·01 | 79·98 |
| a 22 . . . . . | 5·15 | 70·51 | 24·34 | 53·16 | 75·39 |
| C 23 (1) . . . . | 5·86 | 64·54 | 29·60 | 40·00 | 61·97 |
| C 25 . . . . | 5·27 | 68·64 | 26·09 | 51·60 | 75·18 |

Like green and red stems, no difference in favour of any one condition is shown by the results. Low and high percentages of oil are available in both spiny and smooth capsuled types.

In conclusion, I have to express my indebtedness to Mr. J. A. H. Duke, Oil Expert to the Government, United Provinces, for making analysis of some samples, and to my assistants, the late B. Baijanti Prasada, for help rendered in the field.

## CONCLUSIONS.

A large quantity of castor oil-seed is consumed in the Cawnpore market for crushing in the local mills. The seed purchased by the mill-owners is full of mixtures of various kinds, differing in the percentages of oil, shell and moisture, etc. In order to bring to the notice of the cultivators and the mill-owners the risk they run in growing and purchasing seed in a haphazard manner, and to show the advantages of growing and crushing pure types of such varieties which contain high percentage of oil, and possess other useful economic characters, pure cultures of various types were isolated at the Government Farm, and analyses were made of them. These show definite conclusions, which are summarised below. Besides these results, estimates of growing the crop on an acre basis is given. The crop is not sown in these provinces as a single crop, and the information contained would be useful to zemindars interested in its cultivation on a large scale. The following are the results shown by various analyses :—

(1) Some of the varieties found in these provinces are superior to the outside ones, and contain a fairly high percentage of oil (54 to 56 per cent. of oil in the whole dry seed).

(2) Application of different manures showed that cow-dung was best for increasing the yield and the vegetative growth of the plant, while *neem* (*Azadirachta indica*) cake appeared to suit best for increasing the oil percentage. The latter was also helpful in warding off the attacks of insects.

(3) The small-seeded varieties showed greater percentage of oil in their seed than the big-seeded ones. This is probably due to greater compactness of the endospermic material in small-sized seed.

(4) The seed of the central branch of a plant always contained greater percentage of oil than the seed of a side branch. The central branch bears the largest number of fruits, and generally matures earlier than the side branch. The greater percentage of oil in its seed may be due to its early maturity.

(5) The oil-content of castor seed depends more upon the degree of maturity than on any thing else. Even a few days' difference of maturity brings in a considerable effect in their oil percentages. The present method of harvesting green and unripe capsules, as practised by cultivators, is faulty. It is recommended to grow only indehiscent varieties and thereby harvest only ripe fruits.

(6) Analyses of seed from dehiscent and non-dehiscent fruits, green and red-stemmed plants, spiny and smooth-walled capsules, were also made, but no difference in oil percentage was found in them. High and low percentages of oil were found in both conditions of each phase.

The ideal plant should have big, densely crowded, fruiting racemes (Plate XXII, fig. 2), high yield, indehiscent thin-walled capsules of uniform maturity, containing small-sized seed, with the highest possible oil-content. The material being available, the main problem would be to combine these useful characters into one or more commercial types. The breeding of such varieties is in progress, the results of which would be published in the next paper.

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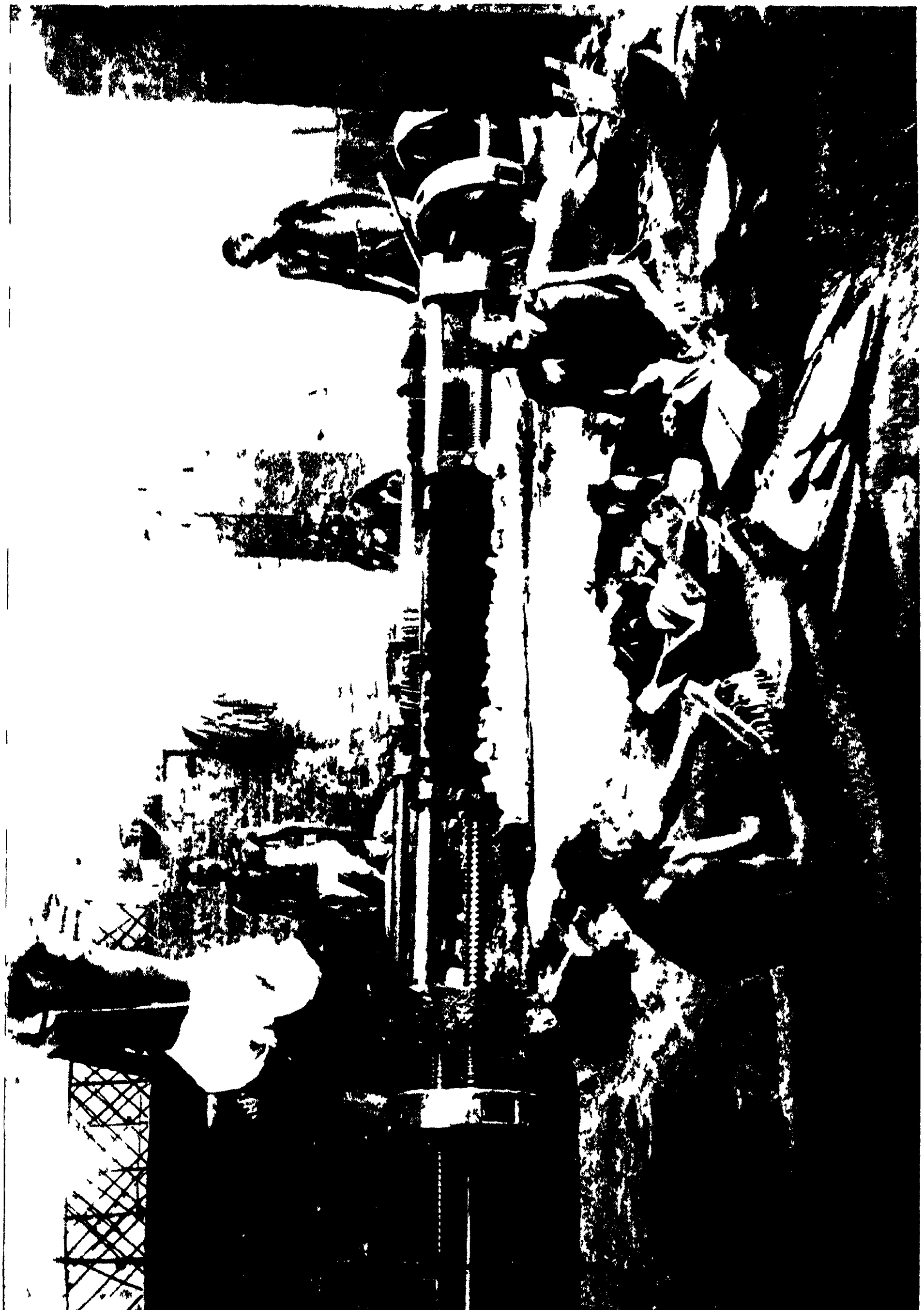


Hand Power Screw Press at work with castor seeds.

PLATE XX.

Pure variety of *Ricinus Communis* grown on one acre as single crop

Fig. 1. Racemes bearing smooth and spiny walled capsules.

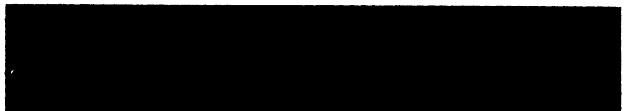


Fig. 2. Spikes showing non-dehiscent and dehiscent capsules.

Fig. 3. Young spike showing male and female flowers.

RICINUS COMMUNIS.

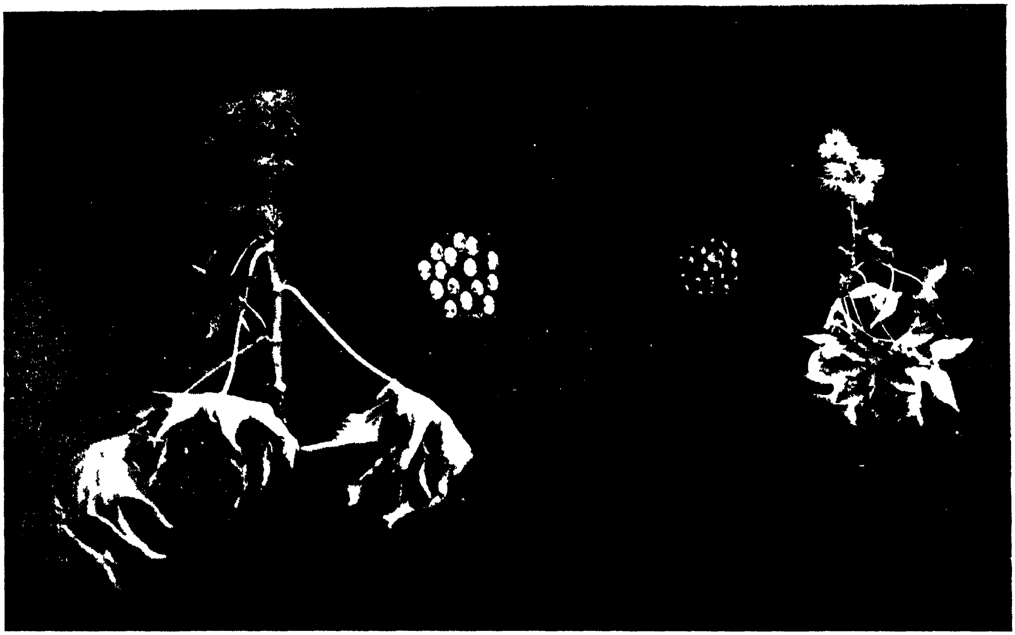
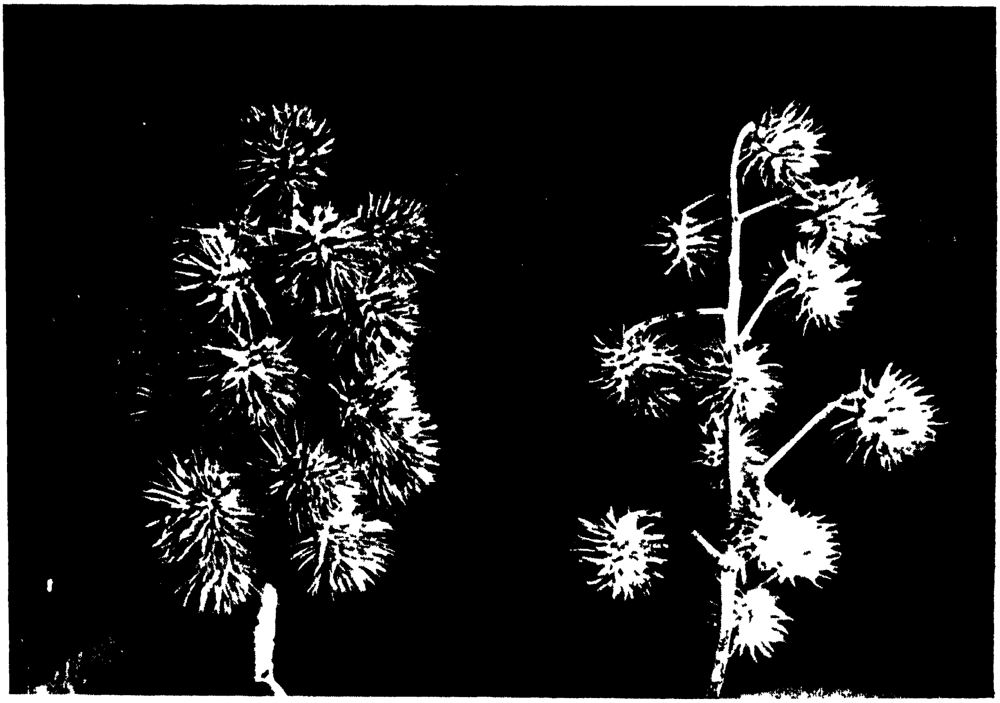


Fig 1 Typical big and small seeds



2 Compact and loose fruiting racemes
RICINUS COMMUNIS

PLATE XXIII.

Fig. 1. Basal branching.

Fig 2 Top branching.

RICINUS COMMUNIS

# THE LIBERAL USE OF FERTILIZERS IN THE SEED-BED AS A POSSIBLE MEANS OF REDUCING MANURE BILLS.*

BY

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This paper is only of a suggestive nature and is intended as a plea for more experimental work on the field scale on the possibilities of cutting down manuring costs, in the case of transplanted crops, by liberally manuring the seed-bed.

In the course of investigations in plant nutrition it was noticed that plants absorbed large quantities of nutrients in their very young stages, that this absorption varied with the nature of the manurial treatment, and that young plants that had the benefit of a good start in the beginning were better able to withstand adverse conditions in their later life than plants that started under less favourable conditions.

If the benefits of manuring are impressed upon the plant even in the earliest stages of its life, it would be reasonable to expect seedlings grown under well-manured conditions to do better after transplantation than those grown under inadequately manured or unmanured conditions. The first experiment to test this point was carried out in 1926-27. *Ragi* (*Eleusine coracana*) was sown in small manured and unmanured seed-beds, and when the seedlings were 40 days old, they were transplanted into an unmanured soil of moderate fertility with the following results :—

| | grms. |
|---|---|
| Yield of crop from manured seedlings . . . . . . . . . . | 31·11 |
| Yield of crop from unmanured seedlings . . . . . . . . . | 19·44 |

A repeat experiment in small pots in the next season with *ragi* gave similar results.

| | grms. |
|---|---|
| Dry weight per matured plant from seedlings 34 days old from unmanured bed . | 1·51 |
| Dry weight per matured plant from seedlings from mineral-manured seed-bed . | 1·58 |
| Dry weight per matured plant from seedlings from cattle-manured seed-bed | 1·84 |

* Paper read at the Agriculture Section of the Indian Science Congress, Nagpur, January 1931.

Encouraged by the results of these preliminary experiments, a third experiment was carried out under more rigorous conditions.

*Ragi* was again the grain used in this experiment. Seedlings 30 days old raised in small differently treated seed-beds were transplanted into 18 small unmanured ground plots of moderate fertility. The results are given below :—

| Plot No. | Average dry weights of plants raised from seedlings from unmanured seed-beds | Average dry weights of plants raised from mineral-manured seed-beds | Average dry weights of plants raised from cattle-manured seed-beds |
|---|---|---|---|
| | Grms. | Grms. | Grms. |
| 1 . . | 1·05 | 0·96 | 1·54 |
| 2 . . | 0·93 | 1·13 | 1·17 |
| 3 . . | 0·91 | 1·00 | 0·81 |
| 4 . . | 0·92 | 1·80 | 1·44 |
| 5 . . | 1·23 | 2·36 | 2·33 |
| 6 . | 1·29 | 2·17 | 2·30 |
| Average . | 1·06 | 1·57 | 1·60 |

$$\frac{\overline{\text{Min}} - \overline{\text{No}}}{\sigma} = Z = \frac{0{\cdot}51}{0{\cdot}47} = 1{\cdot}09 \text{; odds nearly } 30:1$$

$$\frac{\overline{\text{Fym}} - \overline{\text{No}}}{\sigma} = Z = \frac{0{\cdot}54}{0{\cdot}42} = 1{\cdot}30 \text{; odds more than } 30:1$$

A similar experiment was carried out with cotton. The transplantation of the cotton seedlings was successful; seedlings transplanted from manured seed-bed grew better than seedlings from unmanured seed-bed, but the experiment could not be carried through to completion as the plants had an attack of stem weevil which was general. In the case of plants grown from seedlings raised in unmanured seed-beds all the plants succumbed to the attack of stem weevil; of the plants grown from mineral-manured seedlings there were 80 per cent. deaths; while in the case of plants raised from cattle-manured seedlings the deaths were 60 per cent.

The trials were next extended to sugarcane. By the courtesy of the Government Sugarcane Expert, Rao Bahadur T. S. Venkatraman, and Mr. N. L. Dutt, Second Cane Breeding Officer, of the Imperial Department of Agriculture, these trials were carried out on their Cane Breeding Stations.

Sugarcane setts from canes grown in differently manured plots were planted in an unmanured field, and allowed to grow to maturity. When the crop was ripe it was harvested. The experiments will be discussed in full detail in another place. For our present purpose it would be enough if we took the total yield of mature cane from setts obtained from differently manured plots.

| | lbs. |
|---|---|
| Weight of stripped cane grown from setts from unmanured plot . . . . | 331 |
| Weight of stripped cane grown from setts from mineral-manured plots . . | 527 |
| Weight of stripped cane grown from setts from cattle-manured plot . . . | 517 |
| Weight of stripped cane grown from setts from cake manured plot . . . | 614 |

The results of these experiments are interesting both from the scientific and practical point of view. We are here concerned with the practical interest. This consists in enquiring on the field scale the possibility of cutting down manure bills by raising seedlings in well prepared and manured seed-beds and then transplanting the seedlings in fields which are manured less liberally than usual. Whether this is economically possible under all conditions and whether the saving effected in the manure bill will not be counter-balanced by the expense of transplanting is difficult to say. Trials can, however, be made with crops for which seedling transplantation is a regular practice. The advantage of thin seed-beds over thick seed-beds in paddy cultivation is well known, and in the light of foregoing experiments the thin seed-bed may be interpreted to mean better seedling nutrition than in the thick seed-bed. In regard to sugarcane the results of short crop seed method that is in vogue on the Agricultural Research Station at Anakapalle and its neighbourhood afford encouragement.

For these reasons it would appear that the results of these small-scale experiments are worthy of repetition on a field scale.

# A NOTE ON INVESTIGATIONS INTO FODDER CROPS IN BENGAL.

BY

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The programme of our work in fodder crops consists of the investigation of new species or varieties of suitable fodder crops found to have done well in India and elsewhere, and in the selection of types and isolation of pure lines of these. The growing of fodder crops has not hitherto been a common practice in Bengal, where cultivators have depended on paddy straw, supplemented by whatever green roughage their cattle can pick up. Practically the only fodder crops fed green to cattle are the pulses, *viz.*, *matikalai*, *khessari*, peas and tops of gram, though *juar* is grown to some extent in the Districts of Murshidabad, Nadia, Malda and Rajshahi. By propaganda and demonstration, the Agricultural Department has effected a considerable increase in the demand for fodder. During 1929-30 the district farm at Berhampur sold 1,200 mds. of green fodder, and the cattle farm at Rangpur sold 3,300 mds. of green fodder and 2,500 mds. of silage to the public. A real demand for fodder-crop seeds has also been created, and the supply of seed is insufficient to meet the local demand. Recommended seed is being multiplied, both on Government Farms and through cultivators. The two Live-stock Officers stationed in Malda and Nadia Districts respectively, have made considerable progress in introducing fodder crops. In the District of Malda, within two years of the appointment of the Live-stock Officer, more than 50 Guinea grass plots of from 1 to 2 *bighas* each have been planted. The cultivators have more than sufficient for their own use, and sell half or more of the green fodder to other cultivators at 0-6-0 per maund. In 1929-30 the distribution of Guinea grass roots in the District of Malda amounted to over 50,000.

A new departure is the making of silage from fodder crops. More than 20 silage pits have been made in different villages in the Malda District during the last two years, over 20,000 cuttings of Napier grass have been issued direct from Dacca, while district farms have started distributing cuttings to meet local demand.

## FODDER CROPS INVESTIGATED.

*Panicum maximum* (Guinea grass) :—The Calcutta Pinjrapoles at Lilooah and Sodepur depend on Guinea grass as one of their principal fodders. The Dairy Farm of the Khadi Pratisthan at Sodepur devotes about ⅓ of its area to Guinea grass (*vide* Sir P. C. Roy's article in the Calcutta Municipal Gazette, Sixth Anniversary Number, page 20). Messrs. Edw. Keventer & Co. grow about two acres of this grass and get an average of 1,500 mds. per acre per annum. The Sewage Farm at Dacca has a large area under Guinea grass. Guinea grass was introduced into Bengal by the Agri-Horticultural Society of India nearly half a century ago. Since then it has been cultivated at the Sibpur Civil Engineering College, where there were agricultural classes from 1898 till 1905, and at the Bengal Veterinary College at Belgachia. It was established on the Dacca Farm in 1915. It has been grown at Lilooah on a commercial scale since 1927, and its expansion in the Districts of Malda and Nadia is of very recent origin.

*Pennisetum* :—*Pennisetum typhoideum* (*bajra*)—Japanese Millet—This was introduced from Manchuria through the Department of Agriculture, U. S. A., in 1925-26. This is a variety of *bajra* of very quick growth, coming into flower within 4-6 weeks of sowing, and grows to about 5-8 ft. in favourable circumstances. It is a very early catch-crop and prefers light soil. This is only equalled in its earliness by a *bajra* type received from Lyallpur, Punjab, and in yield by a selection of *bajra* from the Department of Agriculture in Madras, known as Camboo II. Camboo II grows well, and is a heavier yielder than the Lyallpur strain, but is about a week later in maturing than Japanese Millet. Japanese Millet and Camboo II give similar yields. Last year 11 mds. 37 srs. (about 950 lbs.) of seed of Japanese Millet was distributed from the private farm of the Maharaja of Cashimbazar, at Banjetia near Berhampur (Murshidabad).

*P. purpureum* (Napier grass) :—This was introduced from Peradeynia, Ceylon, in 1927. It tillers heavily, and it is very easily propagated from cuttings.

In comparative tests on the Dacca Farm, without irrigation, Napier grass gave an outturn of 877½ mds. per acre of green feed up till 6th December, and Guinea grass a yield of 467¾ mds. per acre during the same period.

Napier grass grows quicker than Guinea grass. It is recommended by the Bengal Department of Agriculture, and has been distributed to cultivators. The Home Crofters Association—a co-operative organization started under the Anti-malarial Society, Calcutta, has taken 6,500 cuttings this year, and the Ram Krishna Mission Home, near Birati, has grown it with great success and relies on it as the main cattle fodder. Over 10,000 cuttings of this grass have been distributed to

different districts in the Province. The analysis, as given by the Ceylon Department of Agriculture, gives it a higher place than Guinea grass in nutritive value.

*P. Merkerii* (Merkers grass):—This was introduced in July, 1930, from the Philippines. It looks very like Napier, but seeds more freely. The outturn appears to be as heavy as Napier grass, but the nutritive value as compared with the former has yet to be determined.

*P. cenchroides* (Anjan grass):—This was introduced from the Punjab, and grown in Dacca, Berhampur, Nadia, Mainaguri and Rangpur Cattle Farm. The crop at Rangpur during 1927-28 was good, but it did not fulfil the promise it gave in the first year. It suits comparatively light soils, and makes a good hay, but it is doubtful if it will adapt itself to heavy rainfall.

*P. clandestinum* (Kikuiu grass):—Cuttings were obtained from Peshawar and were grown both on cultivated land and on sod. The crop could not make headway in the grass mixture of the locality, notwithstanding hard weeding, and eventually died out. It has been rejected as unsuitable. The grass is more suitable for light rainfall tracts.

*Coix aquatica* (Coix species):—This is found wild in low Jheels in Bengal and was cultivated as a fodder on low land at the Chinsurah Farm, where transplanted paddy could not be grown. The yield in two cuttings, on an average of the two years 1927-28 and 1928-29, was 332 mds. per acre per annum. It is a suitable fodder for marshy land or land which cannot be easily drained, yet which retains insufficient water for transplanted paddy crops. *Coix Lachryma-Jobi* (*Adlay*), introduced from Ceylon, was tested as a highland crop against the above at the Chinsurah Farm, but proved unsuccessful. At Rangpur Cattle Farm it grew fairly well but was not relished by cattle. *Adlay*, moreover, is subject to attack by smut.

*Euchlæna mexicana* (Teosinte or *rheana*):—This was tried on a large scale in the years 1927-28 and 1928-29. It gives a high yield but is later in maturing than maize, and requires more attention than *juar*. It yields heavily in soils rich in lime. In Chinsurah the yield has always been heavier than that of *juar*. In such soils cultivation of *rheana* can be recommended. The stem is very pithy, and is refused by cattle if the crop is allowed to mature. For this reason it is not recommended for siloing. It has yielded at Dacca 529 mds., and at Chinsurah 523 mds. per acre.

*Tricholaena rosea* (Natal grass):—This was introduced through the Department of Agriculture, Washington, U. S. A., in 1924-25. It is a reedy grass with a slender stem and showy flowerhead. It stands drought much better than indigenous grasses and endures heavy cuttings and pasturing. It spreads automatically into adjacent grass-lands. In field-tests last year, it gave a yield of 221 mds. per acre

without irrigation, and up to December, 1930, 259 mds. per acre have been cut, and another 70 mds. are expected before March. The nutritive value is not known, but it is very promising as a pasture grass.

*Zea Mays* :—In 1927-28 a collection of maize types was made, and in comparative tests it was found that a few types of Kalimpong Maize and some of the silage corns from the Southern States of U. S. A. gave promising results. In further tests the American varieties gave higher outturns than Kalimpong types. The American ensilage maize yielded, in small-plot trials, an average of 861 mds. per acre of green matter as against 732 mds. by local types. These tests will be continued for four successive seasons.

*Andropogon* sp. :—*Andropogon Sorghum*, the common *juar* :—

Work on *juar* has been concentrated on obtaining (1) early types for green feeding and (2) heavy yielding types suitable for silage making. Several early types have been selected and acclimatized, some of which come to flower within 46-50 days of sowing. *Juar*, obtained from the Punjab, was the principal source of early maturing types.

A heavy-yielding type has been isolated from Berhampur (Murshidabad) *juar*, and a still later type is being studied.

Other species of *Andropogon* under investigation are *Andropogon purpureo-sericeus*, *A. monticola*, *A. pertusus*, *A. annulatus* and *A. contortus*. Amongst these, *A. purpureo-sericeus* is promising, but the stem is hard if it is allowed to fully mature, and as it is a shy seeder, it takes a considerable time before extensive field-tests can be laid down.

*Holcus halepense* or *Andropogon halepense* var. *Sudanensis* :—Sudan Grass—A near relative to *juar* and Johnson grass, it was introduced in 1924-25 from the United States. A further consignment of seed was received later from Australia. It has proved popular in the Districts of Murshidabad and Nadia. Normally it does not require irrigation during the *rabi* season. It is an annual, suitable for both *kharif* and *rabi* seasons, particularly the latter. It gave an outturn of 250 maunds per acre at the Sewage Farm, Dacca.

*Andropogon halepense* or *Sorghum halepense* (Johnson Grass or *Bhuroo*) was obtained from the Punjab in 1928.

This has a deep underground runner system, and in moist sandy loam soils where the water-table is high, it is a successful perennial pasture crop. It has largely replaced the obnoxious grasses growing by the side of a canal at the Rangpur Cattle Farm. The outturn obtained has been 250 maunds 36 seers per acre in the first year, and 294 maunds during the second year.

*Oats* (*Avena sativa* Linn.) :—Two varieties of fodder oats received from the Punjab (imported from England) have proved most successful from the point of view of fodder raised. These set seed in the hills but not in the plains, and present efforts are directed towards obtaining heavy fodder varieties which will seed in the plains. In this connection four other varieties as well as local types raised at Pusa are now being tested.

We are also studying a large collection of grasses, *e. g.*—

(a) *Chloris Gayana*,

(b) *Paspalum Commersonii*,

(c) *Paspalum dilatatum*,

(d) *Panicum muticum*,

(e) *Panicum abyssinica*,

(f) Teff grass (*Setaria* sp.)

and various other grasses introduced from Australia, the United States of America and the Union of South Africa. None of these has been studied long enough to justify conclusions, but *Panicum abyssinica* shows some promise, being one of the few grasses which has good leaf surface and has stood inferior moisture conditions at Dacca. This grass is now being tested on a field-scale.

The following grasses are also being studied :— Two local grasses, one collected from Chittagong Hill Tracts and the other from the Char lands of the Buri Ganga, Dacca, in July 1930, seem very similar in vegetative characters to Napier grass. They have not flowered so far and have yet to be identified. Both are soft and tiller well, with stems somewhat thicker than those of *P. purpureum* and *P. Merkeni*.

*Leguminous crops* :—*Centrosema pubescense*, introduced from Java, is very promising. It is a very good soil-binder, making its full growth in the second year. It prefers a well-drained light soil and can stand drought, but the leaf surface is rather small.

*Centrosema japonica*, introduced from Peradeynia in 1928, has a greater leaf surface, but is not so long-lived as the former; also it seeds very sparsely.

*Calopogonium mucunoides*:—The seed was obtained from Peradeynia, Ceylon. It is an annual and covers the soil very rapidly, but dies off during the dry months. The pods when mature are hairy; so that it be fed to cattle whilst the pods are still green.

*Vigna* Sp.—*V. oligosperma* a creeper indigenous to Java, with a small leafy surface, perennial in habit, grown at the Dacca Farm during the last three years, seeded very sparsely and has been rejected.

*V. Catiang* :—Several American types of cowpea have been introduced, *viz.*, New Era, Iron, Brabham, "Whip-poor-will" and Groit. "Whip-poor-will" as obtained was mixed, and several new types have been isolated. Of these one with black seed is the earliest, coming to flower in the *rabi* season within 40 days of sowing. Even in adverse conditions it is ready for feeding within two months. Generally they do not appear to be suitable as *rabi* crops, north of 24° latitude, but the American strain "Groit" is an exception and holds considerable promise in this respect.

Further selection, both of local and imported types, is being made.

*Phaseolus Ricciardianus*.—The *mayshiam kalai* from Darjeeling and *sabai kalai* from Hill Tippera are being studied. At Rangpur, *mayshiam kalai* yields a heavier crop, but the period of growth is longer than that of cowpea as it prefers a cooler climate. There are various types of *P. Ricciardianus* which vary in the size and colour of seed and the habit of the plant and in the length of growing period. Several pure lines have been isolated and are being examined and seed will be multiplied to enable more extensive tests being undertaken.

*Mucuna* sp.—Velvet beans introduced from the United States, Mauritius beans from Australia, and the local *Toru-kola sim* and *Biral sim* or *Banarulla* have been under test. Some of the types found have yet to be identified.

The beans have been grown both as a *rabi* and as a *kharif* crop. *Toru-kola sim* grows well under field conditions, yielding a heavier crop than either cowpea or *mayshiam kalai*, though it is somewhat coarse. The nutritive value of *Toru-kola sim* as well as those of velvet beans at different stages of growth, have still to be determined.

*Mucuna pruriens* (*Biral sim*) promises to be a good fodder crop, as it has heavy foliage. The pods, when mature, are covered with irritating hairs, so the crop must be cut when in flower.

(*Alysicarpus rugosus*) :—This grows well under Dacca conditions, and the stems remain quite soft even in plants three to four feet high.

*Gouara* (*Cyamopsis psoraloides*) :—This cannot compete with cowpea in the rains, and does not mature unless irrigated in the winter season.

*Lucerne* (*Medicago sativa*) :—This has been subjected to prolonged trial at Dacca and Rangpur but so far has not been successful, in spite of inoculation of plots with soil from up-country.

*Dolichos Lablab* :—A field variety, introduced from Bombay, was tried as a *kharif* crop and showed promise in the first year.

*Vetches* (*Vicia sativa*) :—Two indigenous vetches gave a poor outturn and were rejected, vetches from Oregon and Russia, and two Australian species are under test.

*Melilotus alba* and *M. indica* do not thrive in the Dacca Farm soil, neither does *Trigonella* sp., *Melilotus alba* suits *Char* lands ( silt recently deposited by big rivers) but it was rejected, as it gave very little green matter. Hubam clover or Sweet clover, introduced from the United States of America, was also found unsuitable.

*Helianthus annuus* :—Russian Mammoth Sun-flower was tried as a *rabi* crop in the Berhampore and Rajshahi farms. It does not thrive as *kharif* crop, but is successful in the *rabi* tracts where there is sufficient moisture. Cattle dislike silage made from sun-flower alone, but accept it readily when mixed with *maize* or *juar*. The yield is considerably less than that of either *maize* or *juar* and further cultivation has been discontinued.

*Fodder Peas*-(*Pisum sativum*) :—Two Australian peas were introduced this year, and will be tested against other imported and local field peas.

The cultural or botanical work on fodder crops must be incomplete unless it is supplemented by nutritive tests which would tend to save unnecessary work in selection and breeding with undesirable or inferior crops. At present the only factors which can be taken into account are yield and palatability. The cultivation of high-yielding crops of low nutritive value is uneconomic, the soil being unnecessarily impoverished, and the energy of the stock fed is taken up in digesting fibrous matter.

*Outturn of Guinea vs. Napier, Sewage Farm, Dacca.*

Guinea Grass

| No. of plot | Area of each plot acres | No. of cuttings taken | No. of days from 1st to last cutting | Yield per plot in mds. of 82 lbs. | Yield per acre in mds. of 82 lbs. | Yield per acre in tons | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | 0·94 | 6 | 355 | 2901 | 3085 | 113·4 | 5th year's harvest and high land. |
| 2 | 1·15 | 8 | 343 | 1958 | 1702 | 62·5 | 3rd year's harvest. Medium high land. |
| 3 | 0·83 | 5 | 312 | 1158 | 1396 | 51·3 | 3rd year's harvest. |
| Average Yield . . . . . . . . . . . . | | | | | | 75·4 | |

Napier Grass

| No. of plot | Area of each plot acres | No. of cuttings taken | No. of days from 1st to last cuttings | Yield per acre in mds. of 82 lbs. | Yield per acre in mds. of 82 lbs. | Yield per acre in tons | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | 0·29 | 5 | 237 | 520 | 1793 | 65·9 | 1st year's harvest. |
| 2 | 0·20 | 5 | 243 | 433 | 2165 | 79·5 | Ditto. |
| 3 | 0·05 | 6 | 347 | 247 | 4940 | 181·9 | 2nd year's harvest. |

Average Yield . . . . . . . . . . . 109·1
Yield per acre in favour of Napier . . . . . . . 23·7. *i.e.*, 46 per cent.

# HOW MANY TIMES WILD PIGS BREED IN ONE YEAR?

BY

DAMODAR M. DAMLE, B.A., LL.B.

This is a short article giving data collected by the writer on a subject which has not received much study or consideration in India; the writer therefore ventures to put forward his data, with a view that the subject may be fully discussed by the readers of this Journal. The Board of Agriculture has passed resolutions recommending special appointments for studying the habits, weak points and other details about wild pigs: the Bombay Government Committee on Wild Animals (1923) also made similar recommendations for an intensive study of habits of wild pigs. The writer gives below the data collected by him, and begs to say with emphasis that the study should be taken up at once in the interests of Indian agricultural development. The writer is closely connected with cultivation, and has studied the subject of crop protection on his farms which are situated near government forest reserves. He has been carrying out wild animal destruction campaigns, and has carefully tried to collect all available details about wild pigs and other animals destroying crops in his fields. The writer therefore gives his experience and invites opinions and information to confirm or disprove his theory that wild pigs breed only once a year. The writer bases his theory on his killing of 130 wild pigs in last summer and his observation of the dissected bodies of sows in his campaign. He saw that not even one sow out of the 48 sows shot and trapped by his party was either pregnant or accompanied by piglings of less than 4 to 6 months old in April, May and June 1930. Some more pigs were shot by servants of the writer in September and October 1930, and two of the sows contained well-developed foetus. The writer bases his observation on more than 50 sows, and says that wild pigs breed only once a year and not more. In the course of a campaign carried out for three months in government forest under a special permit from the C. P. Forest Department, he came across grown-up piglings of at least 6 to 8 months' growth in the summer of 1930: smaller young ones were never met with going with grown-up sows. He therefore asked Mr. Bhide, Officer in charge, Pig Campaigns (of Bombay Agricultural Department), his opinion on this point. Mr. Bhide has been doing work of pig destruction in their own habitat for a pretty long time, and his opinion deserves consideration. He is confident from his observation that wild pigs breed only once a year: he says that the assumption that there are two breeds in a year seems to be based on the fact that in a herd of two sows and one male, they are covered in different months, and so there is apparent differ-

ence of about 2 months in the age of piglings. This fact may be the explanation according to Mr. Bhide of the impression that there are two broods in a year, piglings of different sizes being seen in the same herd. The writer also sought the experience of Bisson Pardhie, the leader of the gang of Pardhies, working with traps in the writer's campaign. This man with a life-long experience of wild game of all sorts has grown grey in his calling of trapping wild animals and must have killed over 200 wild pigs at the lowest computation. Bisson was of the clear opinion that wild pigs breed only once a year in September-October in this part of the country. The Pardhie leader told the writer that solitary males mix with sows and herds in May-June and gestation then commences. The writer therefore bases this theory on the above opinions of Bisson Pardhie and Mr. Bhide and his personal observation. It seems that in various zoological gardens in India wild pigs breed twice or more : no two opinions about breeding of wild pigs in state of captivity agree, and it is doubtful if this observation as regards artificial conditions would hold true in the natural habitat of wild pigs.

The opinion and experience of Mr. Bhide, Pig Killing Officer of the Bombay Agricultural Department, was ascertained by personal communication by the writer.

It will thus be seen that observation of breeding of wild pigs in natural habitat agrees on the point of their breeding only once a year, whereas opinions from different parts of India show great divergence on this point of breeding of the same in captivity. The writer is inclined to think that, in the wild state, pigs breed only once a year and not more, the season of breeding being different in different parts of the country, depending on climate or other environments. Mr. Bhide has observed that on Prawara Canals he found pigs carrying young in April in his wild pig campaigns ; but on Goda Canals and in Jungle Tracts the usual time of pregnancy of wild pigs was observed by him to be July-August-September-October. Mr. Bhide could not find sows indicating pregnancy in June on Goda Canals and Jungle Tracts worked by him. Thus the close observation of Messrs. Bhide and Bisson Pardhie who have been studying wild pigs in their habitat for a long time and experience of the writer of more than 150 wild pigs killed off and on in the course of one year and his observation of their habits go to show that wild pigs breed only once and not more in India. The writer begs to invite criticism on this theory : by way of explanation to wild pigs breeding more than once in captivity, he begs to say that there is a well-known biological principle that in captivity sexual activity is markedly more than in free condition. This fact may account for different observers recording wild pigs in captivity breeding twice or more.

# HOW TO INCREASE THE YIELD OF RICE IN THE KONKAN.*

BY

V. V. GADGIL, B. Ag.,

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The Konkan Division of the Bombay Presidency consists of four districts, *viz.*, Thana (including the Bombay Suburban area), Kolaba, Ratnagiri and Kanara. The geographical position of this Division is very peculiar as it consists of a long, narrow strip between the Sahyadri mountains and the Arabian Sea. Unlike the Deccan the soil of this Division is not so retentive and fertile, and the scope of agricultural improvement is extremely limited on account of the small uneconomic holdings on the slopes of the ranges. In the northern parts of the Thana and Kolaba Districts the soils are chiefly derived from the trap rock, while the Ratnagiri and Kanara soils are derived from laterite and granite rocks. It would appear at a glance that this Division is in a very fortunate position as regards assured rainfall which vary from 75 inches in the northern part of the Thana to 150 inches in the southern portion of the Kanara District. All this rain, however, falls in three or four months from June to October, and from the month of November to the end of May very little rain is received.

The paddy crop is one of the most important crops in the Konkan as it occupies more than 10 lacs of acres, or nearly half the area under rice in the whole of Bombay Presidency. Although the area under rice is fairly large, the outturn of rice cannot be favourably compared with the leading rice-growing parts of India or of the foreign countries. One of the most striking features of rice in the Konkan is the comparatively low outturn per acre as compared with the rice-growing countries in the world. When Spain can produce 5,000 lbs .per acre, Italy 3,300 lbs., the average yield of the Konkan Division is only 1,100 lbs. The causes of such a low yield are too many and in some cases out of control. But from the experience gained so far it may be said with certainty that the present low yield of rice can be increased by 50 per cent. by adopting judicious methods of cultivation which are the net results of the application of intensive scientific methods to study the rice plant.

On account of the important position held by the paddy crop in the Konkan, the subject of rice improvement forms the main theme of work of the Bombay Agricultural Department in this Division. The Department at present possesses a few farms in the representative tracts of the Konkan at Karjat, Ratnagiri and Kumta.

* Paper read at the Agriculture Section of the Indian Science Congress, Nagpur, January 1931.

The research in rice crop is being done in this Division in two directions for the last decade, *viz.*, (1) by increasing the yield of rice by evolution of high-yielding varieties and (2) by cultural methods, such as, manuring, tillage, etc. It is a well-known fact that the soil and climatic conditions vary very widely in all the different tracts of the four districts and, as a result, the cultivator had to choose a variety suitable to this tract. The land can be broadly classified into upland, low land and intermediate according to its situations, and in every locality three different varieties of rice are generally found to suit the requirements of the above mentioned types of soils. Further the variety is required to be changed according to the condition of rainfall, retentiveness and physical properties of the soil, and thus one can observe more than three hundred varieties of rice cultivated in this Division, and this fact will also give an idea of the difficulties in the introduction of improved varieties in the Konkan. Another striking factor marked in this Division is that the yield of grain in Ratnagiri comes to 1,200 and that of Kanara comes to 1,000 lbs. per acre. On the other hand, the percentage of straw is found exactly in the inverse ratio. If the percentage of straw in Thana and Kolaba Districts is 80 per cent. of the total quantity of grain, the proportion of straw in Kanara District is nearly 150 per cent. of the grain. As a matter of fact, the soils of Kanara receive a large amount of leaf mould and a heavy rainfall, while in Thana and Kolaba Districts very little bulky manure is added to the soil. With regard to the rainfall the Kanara District is far better situated than the northern part of the Konkan. Why therefore the yield of Kanara soils should be lower than that of Thana and Kolaba ?

The rice crop shows remarkable variation in the ratio of grain to straw under different conditions, and the variation caused by the relatively higher weight of straw when compared with grain is called unbalanced growth. One of the reasons for such a heavy weight of straw is the excessive manuring with nitrogenous stuff stimulating the vegetative growth without increasing the weight of grain. Other causes which bring this heavy yield of straw may be due to the quality of the soil as well as inheritant character of the particular varieties of rice. Deficiency of soil moisture, close spacing and lodging may also bring the unbalanced growth.

With regard to the soil, it has been already stated that the trap soils of Thana and Kolaba are fairly rich in potash and phosphoric acid and they are deficient only in nitrogen. This is why only nitrogenous manure, such as sulphate of ammonia, is found more effective for rice crop in trap soil. On the other hand, the laterite and granite soil of Ratnagiri and Kanara are both deficient in phosphoric acid as well as nitrogen, and hence a combination of nitrogenous as well as phosphatic manure respond fairly well in these soils. Further it should be observed that trap soils are more or less alkaline, while Kanara soils are acidic in quality.

With regard to the varieties existing in this Division, a marked difference is seen between the varieties grown in Thana and Kanara Districts. In the Thana and Kolaba Districts people prefer soft white rice called *kolamba*, having a higher percentage of starch, while in Kanara there is a tendency to select a parboiled glutinous rice, which is very hard for digestion and requires boiling before hulling. It is not known why the people prefer coarse rice in Kanara when they can produce a better quality of table rice. If a cultivator is really anxious to increase the yield of rice, he must choose his liking for a finer quality of rice.

The methods of tillage are also adopted according to the conditions of soils and the variety of rice selected. In the north Konkan, 30 lbs. of seed grown on four or five *gunthas* of *rab* is quite enough to produce seedlings sufficient to transplant one acre of land, while in the south, as much as 80 lbs. of seeds grown on 16 *gunthas* of *rab* is required for transplanting one acre. It should be mentioned that the number of grains per lb. is far greater in the case of *kolamba* rice than that of *Halga* paddy of Kanara, and this will partly account for higher seed-rate in these soils. Sowing, broadcasting and transplanting are the common methods adopted in different tracts according to the condition of rainfall and the soil, and they are also responsible for the higher or lower yield of the different tracts.

Up till now the Agricultural Department has concentrated its attention for the breeding of different varieties of rice suitable to the different tracts, and so far they have evolved half a dozen varieties for trap soils, *viz.*, Kolamba Nos. 42, 226, 412, 79, 184, 401, etc., which bring 20 to 30 per cent. increased yield over the local variety. Extensive trials of manurial experiments on rice crop at Karjat have been also conducted, and it has been proved that the addition of 300 lbs. of sulphate of ammonia given in two or three doses would increase yield of grain by 30 to 40 per cent. over the no manure plot, and if the selection of the new strain as well as the manuring with sulphate of ammonia be adopted, a cultivator is sure to get 50 per cent. more outturn over his local variety. But in the case of Ratnagiri and Kanara the problem of reducing the yield of straw and increasing the yield of grain has not been tackled as yet. So far the work of the Agricultural Department is restricted to the selection of high-yielding strain, but unless the percentage of straw is decreased it is doubtful whether the yield of grain can compete with the high yield of Thana and Kolaba Districts. I, therefore, think that crosses between the *kolamba* varieties of Kolaba and *vaksal* and *varangal* varieties of Ratnagiri and a few promising varieties of Kanara should be freely made so that we may come across a strain which would suit the soil conditions of Ratnagiri and Kanara, as the percentage of straw is low in *kolamba* variety and that this character will be found in some of the new crosses and percentage of grain will be increased. Similarly the

manurial experiments in laterite and granite soil should be conducted altogether on different bases which would result in the reduction of straw and increase in grain.

The yield of grain in rice per unit area is the product of a number of earheads in that area and the weight of each earhead. Thus these two factors constitute towards the final yield. It is therefore desirable to study how these two factors behave under different conditions of environment, and thus to find out the causes of low yield.

The effects of various environments, such as age of seedling at transplanting, the number of seedlings to be planted per bunch, strength of seedlings, spacing, methods of cultivation, effects of various manures, time of application of the manure, water requirements, etc., are required to be studied in different tracts of Ratnagiri and Kanara for increasing the yield of rice. From the experiments conducted on the trap soils of Karjat, sulphate of ammonia has been found to be the cheapest and more economical, and a maximum yield up to 4,400 lbs. has been obtained with the addition of 300 lbs. of sulphate of ammonia per acre. This dose, however, is considered to be beyond the means of ordinary cultivators, and efforts are now made to reduce this dose to 200 lbs. of sulphate of ammonia. But as stated above, an intensive study of the effect of manure in laterite and granite soils is absolutely necessary if the yield of rice is to be increased.

In stiff black soils of the Thana District there is a system of double transplanting and also to cut one-third the growth of the rice crop in the month of September, which results in increasing the number of tillers and earheads. These methods are also worth trying in Kanara to check the excessive leafy growth. Another method of reducing the yield of straw is by means of proper spacing of the bunches which would automatically reduce the seed-rate. The cultivators are in the habit of transplanting the seedlings at 4″ to 5″, but if this distance be doubled, there will be ample scope for the development of the plant and grain formation. Another method of increasing the yield of Kanara soil is the introduction of manuring with green leaves instead of dry ones which are generally collected from the droppings of the forest. Experiments conducted in this direction at Kumta Farm tend to show that if an equal quantity of green leaves (4,000 lbs. per acre) be added to the soil, the yield is increased by 100 per cent. over the plot of dry leaves or farmyard manure, and this method is worth introducing on wider scale in Kanara, which contains more than 90 per cent. of the forest area out of the total. There is a system of allotting nine acres of *Betta* land (forest allotted for removing green leaves and loppings) for one acre of species and *supari* garden, and if similar arrangement be made for the supply of green leaves to the rice fields,

it will surely increase the yield of rice. It is worthy to note that the percentage of straw to grain does not increase beyond 120 per cent. in the case of plots manured with green leaves as compared with farmyard manure plots. In this connection it has been observed that some of the quick growing species like *Calatropis gigantia*, *Erythria indica*, *Tephrosia candida*, etc., produce abundant supply of green leaves and respond very favourably when applied to the rice crop. The yield of rice is still further increased if the green leaves are supplemented with two cwts. of bone-meal, and a maximum yield of 4,250 lbs. of grain had been recorded as the result of the combination of this manure.

Another important factor for consideration of the rice produce is its percentage of kernel to husk. In some varieties nearly 50 per cent. kernels are received from the unhusked rice, while in some varieties this percentage is as high as 65 per cent. In the market a merchant always takes into consideration this percentage of kernel while offering the price for rice. The quality of seed must also be given due importance as there is a lot of difference in the prices of the seed of the best quality compared to the price of the coarser types of rice.

If all the above methods be brought into action, it is quite likely that the average yield of rice can be increased by 50 per cent. although further research is required to compete with the high-yielding strains of western countries. In the Konkan the total produce grown in the tract is hardly sufficient for five months' consumption, and for the remaining period people are required to import rice from other Presidencies, especially from Burma, and if the produce be increased by scientific methods, it will supply additional food at least for a couple of months. This is really a national gain which cannot be neglected any longer. In my opinion this subject requires more research conducted in different rice-growing tracts of the Konkan, and if the importance of the problem be brought to the notice of the Imperial Research Council, it is hoped that the Council may sanction the required amount for this research. Similar amounts have been sanctioned for rice research in other Presidencies, and it is not known why the Bombay Presidency should lag behind.

To summarize the whole note, I may draw the attention of the authorities to the following points :—

(1) The average yield of rice in the Konkan is very low when compared with the other rice-growing tracts of India and western countries.

(2) How to increase this yield is a great problem which has been partly solved for trap soils by breeding high-yielding strains and manurial experiments at Karjat.

(3) By the judicious method of the selection of new strains and manuring, the yield can be increased by 50 per cent. in Thana and Kolaba Districts.

(4) So far such a high-yielding strain has not been found in the southern parts of the Konkan where the soil and climatic conditions differ.

(5) The yield of rice gradually decreases as we go from north to south.

(6) On the contrary, the percentage of straw is inversely increased when we compare the yield of rice in the north and south.

(7) How to check this unbalanced growth in the south is a great problem which is likely to be solved (1) by crossing rice varieties of north and south, (2) by radical changes in manuring which require special research, (3) by wider spacing of transplanted rice, (4) by the addition of green leaves instead of dry ones or farmyard manure and (5) by double transplanting, etc., etc.

(8) The percentage of kernel to husk and the quality of seed should be taken into consideration while evolving the new strains of rice.

(9) It is not known why the people of Kanara prefer parboiled and glutinous rice when table rice like *kolamba* can be grown in the tract.

(10) This problem really requires highly scientific research stations located in all the rice-growing tracts, which is only possible with the help of the Imperial Research Council.

# A PRELIMINARY NOTE ON THE OCCURRENCE OF SEPALOIDY AND STERILITY IN *TIL* (*SESAMUM INDICUM*).*

BY

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## Introduction.

*Sesamum indicum* is an important oil-seed crop grown all over India, either pure or mixed. It has invited special attention as the source of most of the sweet oil used in India and owes its agricultural importance to this fact. Howard started a preliminary investigation into the crop in 1909, and in the following year he raised a number of cultures of *til* at Pusa and described the morphological differences between the types. Later again in 1919 he published an account of the method of pollination in this crop. For the last few years pure-line selection in *til* has been going on at the Botanical Area at Pusa. For this purpose, seed, in the first instance, had to be obtained from the different parts of India and grown at Pusa, thus enabling the raising of single plant cultures from the different types of plants obtained from the original seed. In 1926 the crop was characterized by the regular occurrence of a large number of plants bearing sepaloid flowers. On closer examination it was observed that sterility was intimately associated with sepaloidy in these flowers. This fact made the matter interesting from an economic point of view. A very large number of plants bearing sepaloid flowers meant a high percentage of sterility in the crop, and therefore ultimately a net loss to the grower. It was therefore decided to study the morphology of these sepaloid flowers, this study being only a preliminary to a closer investigation into the factors leading up to sterility in the crop ; the observations on the subject are not to be considered as complete. They are, however, reproduced here for what they are worth.

## Observations.

The normal inflorescence of *til* is a lax raceme, bearing the flowers singly or in twos and threes in the axils of the bracts. The flowers have very short pedicels, and are borne in acropetal succession on both the main shoot and the branches. The sepaloid inflorescence, on the other hand, has a large number of flowers

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crowded together closely on the stem and the branches. The flowers are borne in acropetal succession. Generally a single flower comes out in the axil of a leaf and when this flower has grown for some time, two smaller ones come out at its two sides. This arrangement is seen in the inflorescences bearing the actinomorphic sepaloid flower. The zygomorphic sepaloid flowers have an arrangement very similar to that of the flowers in a normal inflorescence. In the inflorescences bearing the sepaloid flowers the bracts often become very broad and quite unlike the ordinary bracts. A plant may have sepaloid flowers only, or there may be branches on it which bear the normal and the partly sepaloid flowers also. The dense over-crowding of the flowers and their complete greenness make it an easy matter to distinguish the sepaloid inflorescence from the normal one.

The floral types of *til* may be divided as follows :—

1. Petaloid or normal flowers. These are always zygomorphic.
2. Sepaloid flowers. Under this head there may be two divisions—
   (*a*) Actinomorphic (*b*) Zygomorphic. (Similar in shape to the normal flower.)
3. Partially sepaloid flowers. These are zygomorphic and the colour of their corolla is pink with green washes of various degrees.

### The Actinomorphic Sepaloid Flowers.

These are almost regular in shape. The sepals are five in number and are quite free. The corolla is gamopetalous and has five distinct lobes. The corolla tube is formed by the fusion of the leaf-like corolla lobes. The corolla tube varies in length between 5 to 10 mms. but it may be smaller in the very tiny flowers. The size of the flowers may also vary from little ones of 4 to 5 mms. to those of 30 mms. or more in length. The veins of all the floral parts are very thick and prominent, and the portion of the tissue between the veinlets is raised into tufts. The stamens are five in number and are almost atrophied. They are seldom, if ever, functional in the truly sepaloid flowers. The anthers are generally reflexed. The carpels are represented by two leaf-like outgrowths, which fuse together at their margins and thus form a pseudo syncarpous ovary. The appearance of this false ovary is like that of a pouch formed by the fusion of two leaves. The veins are very prominent. The false stigma are the tips of the two leaf-like carpels. In the older flowers these spread out like two open leaves. In some cases the two leaf-like structures fuse only to a short distance from their bases, and in place of the ovary one finds two bract-like structures coming out of the corolla tube. A section of this false ovary, both in the actinomorphic and in the zygomorphic sepaloid flowers, shows that instead of the ovules there are small petiole-like outgrowths with distinctly

green apices. These afterwards grow on and give rise to small shoots coming out of the false ovary. These shoots in their turn bear more leaves and later on flowers. Thus it seems that the flower pedicel has an unlimited growth.

### ZYGOMORPHIC FLOWERS.

In these also the sepals are five in number and are entirely free. The gamosepalous corolla has five distinct lobes and is irregular in shape. The corolla tube is cylindrical up to a certain length (which varies in different flowers), after which it gradually expands and assumes the familiar shape of the normal petaloid flower, though the extension of the lower lip, which marks out the ordinary flower of *til*, is not present in these. The anthers are basifixed. The filaments are colourless, but the anthers have a greenish tinge on them. A transverse section of the anther shows a few pollen grains in each locule. But the greater portion of the anther sacs is filled up with vegetative tissue. The few pollen grains present are distorted, and, as the anthers have not been seen to dehisce, they are perhaps not functional. The ovary is bilocular, and in transverse section two small outgrowths are seen in each locule. These arise from an axile placenta and are the primordia of the leaves, which afterwards grow on the shoot coming out of the ovary. This further development of the flower, giving rise to a shoot-bearing leaves, was noticed only in a few cases in the irregular flowers, whereas it was the general rule in the case of the actinomorphic sepaloid flowers.

### PARTIALLY SEPALOID FLOWERS.

In these the normal corolla has greenish splashes on it. The distribution of the green colour varies much in different flowers.

Thus in the place of the normal structures of an ordinary flower, one finds in these sepaloid flowers, structures that ultimately grow out into leaves. The two knob-like outgrowths, reaching the walls of the false ovary, sometimes lead one to think that the ovary is tetralocular. It is in fact bilocular and thus differs from the ovary of a normal flower, which has generally four locules bearing the seeds in four longitudinal series. Another feature in a section of the false ovary of these sepaloid flowers is interesting. Instead of the usual inner wall seen in a section of the ovary of a normal flower, a section of the false ovary in these sepaloid flowers shows hairs and multicellular glands developing from the inner wall of the ovary. The septum separating the two locules of a normal ovary is thin on account of the size and the pressure of the ovules. But in a section of the false ovary the septum is seen to be very thick because of the entire absence of the ovules. In sections, the leaf-like wall of the false ovary shows cells containing chloroplasts.

## Conclusion.

From the preceding observations it will be seen that sepaloidy in *til* is a malformation intimately connected with sterility. The absence of good pollen and the non-dehiscence of the anthers on the one hand, and the complete absence of ovules on the other, make it absolutely impossible for the sepaloid flowers to form seed. The plants having these abnormal flowers on them are thus unable to reproduce under any circumstance. The type of sterility, therefore, is of the nature of impotence. As to the cause of the occurrence of such malformations in the flowers, leading to sterility, nothing can at the moment be said definitely. A large amount of valuable work has previously been done in the investigation of the different types of sterility. Dorsy [1914] in his paper gives a very interesting account of sterility in the common grape, and in that connection sums up all the important literature on the subject up to the date of the issue of his paper. Without going into the details of the various theories as to the cause of sterility, it may be said that the factors causing sterility are very complex and undoubtedly variable. The investigation of the factors causing sterility in *til* is still in progress.

*Acknowledgment.*

The author wishes to record his thanks to Dr. F. J. F. Shaw, the Imperial Economic Botanist, for his suggestions throughout the course of this investigation.

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# THE BEARING OF THE ALPHONSO MANGO IN THE KONKAN AND SOME METHODS OF REGULATING THE SAME.*

BY

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The Alphonso is one of the shy-bearing varieties of mango grown in the Bombay Presidency but, on account of the excellent quality of the fruit, it is most popular in the market and hence is fast spreading in the hilly tract of the Konkan. The absolute freedom of the fruit from fibre, the fairly big size, the beautiful and attractive colour, agreeable flavour and, above all, the good keeping quality have won for it a reputation which is second to none. The only drawback in this variety is its low-bearing, and since the attention of the Agricultural Department has been drawn to this important defect, several lines of increasing the yield have been under investigation. In the present note, however, regulation of bearing by artificial methods, which forms one of the lines in question, will be discussed. A full idea of the bearing of this variety may be gathered by a close examination of the yield of a garden located at Ratnagiri, the centre of mango cultivation, during four successive years, 1927 to 1930.

The Alphonso garden which we are going to study is situated almost on level ground at the foot of a small hill and is roughly a square with sides nearly 400 ft. in length. It is about a mile away from the sea coast and has 80 trees, nearly 30 years of age. The trees in the garden can be roughly divided into two somewhat distinct portions, the lower one with trees planted wide apart and the upper one with trees crowded together. The area of the lower portion is roughly 1,13,200 sq. ft., and there being 41 trees growing on this ground, the area per tree is about 2,761 sq. ft. The upper portion with its area of 46,800 sq. ft. grows 39 trees, each of which has an area of 1,200 sq. ft.

Most of the Alphonso mangoes do not bear every year in the Konkan. They usually bear in alternate years but trees bearing once in 3 or 4 years are not uncommon. Trees bearing year after year are very rarely found. An analysis of the four years' bearing of the 80 trees in the garden under observation shows—

3 trees bearing in all the four years,

11 trees bearing in three out of four years,

* Paper read at the Agriculture Section of the Indian Science Congress, Nagpur, January 1931.

34 trees bearing in two out of four years,

24 trees bearing in one out of four years,

and 8 trees *not* bearing in all the four years (Total 80).

NOTE.—Trees bearing less than 25 fruits have not been taken into consideration.

It will thus be seen that the largest number is of trees bearing in alternate years. The actual number of fruits borne by the trees can be seen from the following table.

| Year | No. of trees flowering out the total of 80 | No. of fruits borne | Average No. of fruits per tree | Average No. of fruits per bearing tree |
|---|---|---|---|---|
| 1927 . . . . . | 40 | 8,511 | 106 | 213 |
| 1928 . . . . . | 30 | 6,201 | 78 | 207 |
| 1929 . . . . . | 38 | 5,999 | 74 | 158 |
| 1930 . . . . . | 29 | 6,339 | 79 | 219 |

Thus, the average yield per *bearing* tree, 30 years of age, is about 200 fruits. The bearing, however, is considerably affected by the spacing allowed to the trees. A very good opportunity of studying the effect of increased spacing on fruiting is afforded by the two blocks of trees in the garden, one with crowded trees and the other with trees spaced wide apart. The trees could be arranged as follows according to their bearing :—

| — | Crowded block | Widely spaced block |
|---|---|---|
| Trees bearing in all the four years . . . . . . . | 2 | 1 |
| ,, ,, three out of four years . . . . . . . | 5 | 6 |
| ,, ,, two ,, ,, . . . . . . . | 10 | 24 |
| ,, ,, one ,, ,, . . . . . . . | 14 | 10 |
| ,, *not* bearing in all the four years . . . . . . . | 8 | .. |
| Total . | 39 | 41 |

It is evident from these figures that when trees are crowded together they tend to become less productive. This seems to be due to want of sufficient sunshine and proper circulation of air. The trees are, however, very vigorous in growth. The

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actual yield of these trees is also considerably reduced as is shown by the accompanying figures.

| Year | Crowded block | | | Widely spaced block | | |
|---|---|---|---|---|---|---|
| | No. of trees flowering-out of the total of 39 | No. of fruits borne | Average No. of fruits per bearing tree | No. of trees flowering-out of the total of 41 | No. of fruits borne | Average No. of fruits per bearing tree |
| 1927 . . | 14 | 2453 | 175 | 26 | 6058 | 233 |
| 1928 . . | 13 | 1611 | 124 | 17 | 4590 | 270 |
| 1929 . . | 16 | 2070 | 129 | 22 | 3929 | 179 |
| 1930 . . | 14 | 1980 | 141 | 15 | 4359 | 291 |
| Average . | .. | .. | 142 | .. | .. | 243 |

Thus the outturn of crowded trees is considerably lessened, both on account of the reduced frequency of bearing and the lower yielding capacity of the trees.

The bearing of the mango is considerably affected by several other factors also, *viz.*, the quantity and distribution of rainfall, a favourable cold season, the production or otherwise of fresh vegetative shoots, insect pests, diseases, etc. The rainfall must be moderate and well distributed especially in the month of June, as it helps the growth of the June vegetative shoots. The relation of the vegetative shoots and flowers will be explained shortly. A temperature of 60° to 70° F. is very favourable in checking the vegetative tendency in plants and inducing them to flower. But these are, evidently, factors which are beyond the control of the human agency. Certain insect pests and diseases have been found to affect the mango crop to an appreciable extent, and it has also been possible to exercise an effective check on them. But it is not the object of the present note to discuss the same. The attention will therefore be focussed on the important relation of the vegetative shoots to the bearing of the mango with a view to see how the latter could be regulated.

If the growth of a mango tree is carefully observed, it will be seen that there are two main seasons in which it is found to grow. These are in June-July and October-November. Very rarely the trees also put forth vegetative shoots in March or April. Taking the concrete example of a tree bearing regularly in alternate years, it is seen that the branches of the tree throw out fresh shoots in June

as soon as the fruiting season is over, usually from the axillary buds on the top of the branches. These again produce shoots in October or November from their terminal buds. The October shoots do not get sufficient time to be mature enough to produce blossoms in the next flowering season, and have consequently to wait for one full year to be able to bear. In the course of this period they pass the two vegetative seasons, following June and October, in a dormant condition. Thus it is almost evident that the wood to be capable of bearing should be usually one year old. The case of trees bearing in successive years, however, is quite a different one. They produce only one flush of vegetative shoots in June, which remaining dormant in October, attain sufficient maturity to be able to flower by December or January when the next flowering season sets in. The wood in these cases is of six months maturity. It seems clear from this that the wood must be at least six months old to be able to bear flowers, and that the trees which produce vegetative shoots in October are unable to bear in the following season.

As already noticed all the trees do not bear regularly. There are some trees which simply go on vegetating and consequently do not bear for years together. There are others which partially flower and partially produce vegetative shoots. If mango cultivation is to be made more profitable, one of the methods would be to regulate the flowering of the trees so that they will bear regularly every year, or at least in alternate years. This can be achieved by three different methods, *viz.*, ringing, pruning and manuring.

The method of ringing for the production of flowers has been already described in detail [Wagle, 1928]. Ringing is a rather tedious process, and if not properly practised, the wound may not heal up and the branch may be deformed. Pruning has been found to be an improvement over this method and is easier to practise. It has been noticed that the tender October shoots are incapable of bearing blossoms. If these are pruned by means of a secateur, the lower June branches which are sufficiently mature develop their dormant buds, which give rise to flowerheads These operations were tried from the middle of October to the middle of March. They were practised on trees partially flowered, and also on those not flowered at all. The result in almost all cases was that the branches pruned up to the middle of November had either their buds dormant, or produced only vegetative shoots. Flowerheads appeared from the treated branches from the middle of November to the end of February, but the operations were very successful particularly in December and January. The success of the operation depends much upon the vigour of the individual tree. Generally, any vigorous tree can be made to flower by pruning. A sickly plant will fail to respond to this treatment. It must, however, be borne in mind that the pruning has to be done

only in case the tree produces vegetative shoots in October ; otherwise the tree will naturally flower. A few branches, pruned in the above manner in the season of 1929-30, produced 450 flowerheads which gave 52 fruits. This means 11·5 fruits per 100 flowerheads, which was almost the normal crop of the season. The effect of continuous pruning has not, however, been observed so far. But it seems the trees so treated will have to be manured to make up for the vigour lost by increased bearing.

Manuring seems to be another method of achieving the same goal. By this method it has been possible to make the trees bear in successive years. The trees experimented with were, however, smaller in size, about 10 to 12 years of age. A dose of four pounds of sulphate of ammonia and 200 pounds of farmyard manure was applied to each tree in June after the mango crop was harvested. The trees produced both the June and the October vegetative flushes, and were still able to put forth blossoms from the October shoots about the end of February. The manuring seems to have hastened the maturity of the vegetative shoots to the requisite extent before the end of the flowering season. The yields of the trees during successive years were as follows :—

| Tree No. | Yield in 1929 | | Yield in 1930 | |
|---|---|---|---|---|
| | No. of flowerheads produced | No. of fruits | No. of flowerheads produced | No. of fruits |
| 130 | 263 | 50 | 181 | 42 |
| 138 | 285 | 67 | 365 | 106 |
| 139 | 200 | 44 | 743 | 88 |

These trees have again been manured in last June. The vigour of these trees has been very well maintained, and there appear very good prospects of their bearing year after year, provided the trees are properly looked after.

Thus, a beginning has been made to tackle the problem of regulating the bearing of the mango, which is very important from the commercial point of view. It is hoped to develop the work sufficiently on more practical lines in the near future.

The thanks of the writer are due to Mr. V. V. Gadgil, Deputy Director of Agriculture, Konkan, for the frequent guidance and encouragement received from him.

REFERENCE.

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# SELECTED ARTICLES

## SOME FACTORS AFFECTING THE FEEDING VALUES OF PASTURES.*

BY

J. M. DICKSON, M.A., B.Sc.

(Reprinted from the *Veterinary Record*, Vol. X, No. 49, December 1930.)

The subject matter of this paper refers only to permanent grass. The feeding value of any permanent pasture may be said to be dependent on three main factors; these are:—

A. Composition of soil.

B. Climatic conditions.

C. The system of management.

Investigations of pasture problems entail considerable difficulties since they deal with a mixed crop, each member of which is competing with another. It can be said fairly definitely that herbage of any pasture depends entirely on the three factors mentioned, where the pasture has been established for any length of time. It has been shown many times that where elaborate mixtures have been used to seed down a field to permanent grass under any system of management, only a few of these species exist for more than a few years. In this connection it may be said that the modern tendency is to sow much more simple mixtures than was the custom in the past. On many of our best pastures it is interesting to note that only a very few species of grasses are found. For example, in the South Nottinghamshire and Leicestershire areas the best feeding land contains very few grasses beyond Perennial Rye Grass, Rough Stalked Meadow Grass, Crested Dog's Tail, and Wild White Clover. It would, of course, be wrong to say that there are no others, but in many cases these four species constitute 90 per cent. or more of the total herbage. The type of herbage to aim at is one containing a reasonably good mixture of grasses and clovers, and this can generally be achieved by proper management. In the past, we have been taught to assess the value of a pasture rather by its clover content than by its grass content, but examination of pastures of high feeding value tends to confute this idea, and we now realise that to get a high feeding value a considerable percentage of grasses is very desirable.

*Paper presented to the Derbyshire Division, N. V. M. A., at Derby, on October 14th, 1930.

## A.—Composition of Soil.

Under the same or similar conditions of climate and management we know that there are very great differences in pastures on different types of soil. For example, the very poor benty pastures on the bunter sand in North Nottinghamshire compare badly with those of alluvial soil of the Trent side, within a very short distance of each other. The difference in soil conditions required to produce quite different pasture is, however, very small; so small, in fact, that the chemist has not yet been able to measure it. To illustrate this I may mention one case of two neighbouring fields on the same farm, managed as permanent grass in exactly the same way for at least three generations. One of these fields (*a*) will fatten big bullocks exceedingly well, but the other (*b*) will only fatten heifers; young stock, on the other hand, did not thrive on the first field, but did excellently on the other. The grass in field (*a*) is said to be 'too strong' for young cattle. This brings up the first of our problems. What is meant by 'too strong'? It is doubtful whether any one really fully understands this at the moment, but I would offer the suggestion that as these strong fields are undoubtedly the richest, the trouble with young stock may be a diet too rich in protein, or a diet too rich in nitrogenous products which have not been fully elaborated.

## B.—Climatic Conditions.

It is a well-known fact that on the same type of soil, and with similar conditions of management, there can be, and are, very different types of pastures. The variation in the same plant under different climatic conditions is in itself a subject of great interest, but I do not propose to go into it here.

## C.—System of Management.

Under this heading I intend to deal with the various items which are under the farmer's control. The chief of these are:—

1. Drainage.
2. Cultivation.
3. Method of Grazing.
4. The use of Cakes, Farmyard Manure, Lime and Fertilizers.

1. *Drainage.*—This is probably the factor of most importance in the growing of any crop, and hardly needs elaboration. Inefficient drainage leads to soil conditions

of such a kind that it is quite impossible for the better grasses to exist, and a special type of vegetation, generally unpalatable to all stock, is characteristic of badly-drained land. The remedy is, of course, obvious, and may be carried out by means of surface drainage, tile drainage or mole drainage.

2. *Cultivation.*—The importance of cultivation of permanent grass cannot be over-emphasised. On normally well-grazed pastures its most important phase, often unthought of by the grazier, consists in the 'hoof cultivation' of the animals. The beneficial effects of hoof treading are in the main due to its effects on the herbage. Generally speaking, it may be said that only the better quality grasses can stand a regular heavy treading. The poor grasses, and flat-leaved weeds, are so injured in the process that they tend to disappear. Where this type of cultivation is well done, little more is necessary than perhaps an occasional harrowing to spread droppings. On land capable of carrying a reasonably high stock, deterioration of the herbage begins as soon as the stock is reduced, very largely on account of less efficient hoof cultivation. Where this is allowed to go on, a good pasture may be very quickly reduced to one of little value, and the herbage may become of such a type that stock will not face it. Under such circumstances, it may be necessary to resort to other methods of cultivation. This type of deterioration is very common, particularly in large parks which do not lend themselves to controlled grazing. In this connection I might mention Hardwick Park, where the County Authorities have experimented on mechanical methods of improving matted pastures. Severe cultivation with a special disc roller in this case led to a marked improvement in the herbage. Such operations, when necessary, should be carried out in the winter, when the ground is soft, and the implement should be capable of cutting well down into the soil, and even of turning up some soil. In extreme cases of matting the treatment should be drastic, and I have seen bad fields converted into very respectable grazing in one year's time by drastic treatment, particularly when followed by the use of fertilizers.

3. *Method of Grazing.*—Woodman, at Cambridge, and others, have shown that to get the best value out of a pasture, it should be grazed down and then rested for a period, then grazed again, and the processes repeated. He showed that cutting at:—

| | April to October lbs. per acre |
|---|---|
| Weekly intervals gave a total yield of . . . . . . . . . | 1,982 |
| Fortnightly gave a total yield of . . . . . . . . . | 2,562 |
| Three-weekly gave a total yield of . . . . | 3,216 |

At the same time he showed that there was little or no, diminution in the feeding value as determined by the protein content up to the three-weekly interval.

| — | Average weekly cut, 1925 | Average fortnightly cut, 1927 | Average 3 weeks cut, 1928 |
|---|---|---|---|
| Digestible protein | 19·97 | 18·75 | 16·66 |
| Digestible carbo-hydrates | 36·10 | 36·50 | 38·65 |
| Digestible fibre | 12·08 | 13·10 | 13·64 |
| Starch equivalent per 100-lb. dry matter | 67·74 | 69 87 | 69·39 |

The fall in protein content in 1928 was not entirely due to the period of cutting, but was due in part to two dry spells which occurred, and during which the protein content fell considerably. It will be obvious from the above that rotational method of grazing will give the largest live weight increase per acre. Woodman's work was done with a lawn mower, but since then confirmatory results have been obtained at Aberystwyth with sheep grazing at intervals of four days, 14 days and 28 days. The four-day period amounted to overgrazing, giving the lowest live weight increase, and had the worst result on the herbage. This overgrazing killed off much of the better herbage, and these plots, consequently, gave the poorest yield in the following year.

3a. *Class of stock.*—The different habits of different classes of stock make mixed grazing the most efficient. The natural instinct of an animal to avoid places where its own droppings have fallen tends to make grazing by one class of stock inefficient. Sheep prefer the shorter growing herbage, but cattle are not generally so particular, they like a good mouthful, and will clean up a fair amount of roughage. Interesting figures of this subject are available from Cockle Park, where the manurial treatment has been the use of slag alone. On an average of 21 years the live weight increases from similarly treated plots are as follows :—

| | |
|---|---|
| Sheep alone . . . . | 103 lbs. per acre, per annum. |
| Sheep and Cattle . . . | 211½ ,, ,, ,, |

4. *Oil Cakes.*—It has also been shown at Cockle Park that the use of cake alone is not sufficient to maintain the feeding value of a pasture. It may be said that the old idea of maintaining fertility on pastures, through cake feeding, is definitely uneconomic, and without the use of accessory minerals it almost invariably leads to deterioration of the herbage, and consequent reduction to live weight increase per acre.

*Farmyard Manure.*—The use of this material on grazing land is not generally to be recommended, and it should be used, where possible, on arable land, or meadows to be layed in for hay. It is not well balanced as a manure, usually being low in phosphates, and its effect is to stimulate the coarser growing grasses. This results in a smothering of the clovers and the finer bottom grasses. Another point of considerable importance is that stock do not graze well on land which has been heavily dressed with farmyard manure. Where there is no outlet other than on grazing land, it should be applied, as far as possible, at the end of the grazing season.

*Lime.*—No general rules can be given regarding the use of lime on pastures, and it is usually difficult, if not impossible, to predict a result. At Cockle Park and many other parks of the country, lime has failed to give an economic return. In other cases it has even given negative results. Generally, it may be said that where slag is used liberally, lime will not as a rule, give any further improvement. On certain extremely acid soils, however, as on certain parts of the coal measures in Yorkshire, where atmospheric pollution occurs, definite responses to lime have been obtained. Acidity, or sourness, is the name given to certain soil conditions which are by no means well understood. It appears to exist in two main forms; one being the result of a mat of decaying vegetable matter, the other being more or less purely mineral acidity. The former, which is often only surface acidity, can be caused simply by inefficient grazing, and in such cases removal of the mat may remove the acidity. The first form may also be the consequent effect of the second form, and in this case removal of the mat may have to be followed by liming before improvement occurs. It is very seldom that lime in itself will remove a mat; though, as an instance, I may cite the removal of such a mat on poor grassland at Midland College, by waste lime from soap works. There is much less improvement from mountain limestone, and practically no improvement from magnesian limestone.

*Phosphates.*—The best-known work concerning the effect of phosphates is that done at Cockle Park, where a dressing of 10 cwts. of high grade slag, followed by similar dressings every sixth year, or half this amount every third year, led to a three-fold increase in stock-carrying capacity. The average of the last six years, 1924 to 1929, is :—

Tree Field :—

| | |
|---|---|
| Plot 6.—*Nil* . . . . . | Live weight increase per acre, 23¾ lbs. |
| Plot 4—5 cwts. slag, 1924 . . <br> 5 cwts. slag, 1927 . . | Live weight increase per acre, 106¾ lbs. |

Since the initiation of the above experiments in 1897 by Sir William Summerville, similar results have been obtained in many parts of the country. Slag gives

its best results on strong land, and its effect appears to be due partly to the phosphate it contains, and partly to the lime, the latter acting as an interchangeable base in the soil. Since phosphorus and lime are the minerals removed in the largest quantity by the animal, the importance of an adequate supply cannot be overemphasised. Similar, if not perhaps so striking, results have been obtained by other forms of phosphate, such as superphosphates, bone phosphates, and more recently by ground mineral phosphates. On the heavier soils the regular use of some form of phosphate seems in itself sufficient to maintain a comparatively high state of fertility, but on the lighter soils, which are usually deficient in potash, the addition of this substance is often necessary before the phosphate can effect its full value. The effect of phosphates is to increase the percentage of clover in the herbage:—

*Percentages of Dry Matter.*

| | CaO | $P_2O_5$ | $Na_2O$ | $K_2O$ | Cl | $SO_3$ | $Fe_2O_3$ | Protein |
|---|---|---|---|---|---|---|---|---|
| Rye Grass .. . | ·49 | ·80 | ·33 | 3·07 | 1·15 | ·99 | 0·5 | 16·06 |
| Clover . . | 1·44 | ·72 | 1·03 | 2·89 | 1·05 | 1·01 | ·07 | 22·44 |

It will be seen from the above figures that, if the effect of phosphate is to increase the proportion of clover in the herbage, it will consequently increase very largely the proportion of calcium, without in any material extent decreasing the proportion of phosphorus.

*Potash.*—Except on the lighter soils potash seldom shows a direct effect on the appearance of pastures. Whether obtained from the soil, or by actual addition to the soil, its indirect effect is very considerable, and consists in increasing the power of the leaf as a carbohydrate manufacturing agency. The available potash thus has a very important bearing on the feeding value of the herbage. It is particularly important where the nitrogen content of the soil is high.

*Nitrogen.*—The effect of nitrogen is generally the most obvious. It leads to greater leaf production, and greater bulk of herbage, particularly of the grass, and in the earlier stages of growth it increases the nitrogen uptake of the plant, with consequent higher protein content. As growth continues, the protein content tends to level down to the normal. It may be mentioned here that the leaf is the most nutritious part of the plant, and is higher in both minerals and protein than is the stem. The effect of nitrogen increasing the bulk of grass makes it important on pastures that they should not be allowed to grow too long before grazing; otherwise, clovers and bottom growth tend to get smothered out. It is now well-known that clover growth is dependent very much on light, and in the struggle for existence in a mixed herbage the prostrate habit of the clovers is a heavy handicap if the top

growth is allowed to go ahead too far. According to experimental work carried out at Aberystwyth, it would appear that even under heavy rainfall (56-in.) one can expect a recovery of protein, equivalent to at least 80 per cent. of the nitrogen applied as manure, with monthly grazings. Without the use of nitrogenous manures the protein in the grasses is to a very large extent derived from the clover root development. The use of nitrogen on pastures was generally condemned as bad practice until within the last few years, but the recent introduction into this country of the system of complete manuring and rotational grazing has done much to make us alter our views. This system entails the use of phosphates and potash as basal dressings, followed by a number of nitrogenous dressings during the growing season. It has been shown by this system that it is possible to maintain herbage of a high protein content from very early in the season throughout the season into late autumn. This is in contra-distinction to normal growth, where the protein content follows a curve somewhat as follows :—

It would appear that there is every probability of a very much greater use of nitrogen on grassland in future. The deterrent features apparent at the moment are mainly economic and technical. There is also the question of the state of the nitrogen in grass at different stages in growth, and how nitrogen, in some of its inelaborated, that is, non-protein forms, affects the living animal. Cases have been reported where animals have behaved abnormally on pastures treated with nitrogen. In one case, at Castle Douglas, cattle appeared to be passing blood and red water was suspected. Investigation, however, showed no parasites, and the presence of complete blood corpuscles with particles of cell wall detritus. This phenomenon occurred fairly regularly, about five hours after grazing had commenced. Chemical investigation of the grass showed a very high content of non-protein nitrogen, amounting to 50 per cent., and the trouble was undoubtedly due to this. This led to an investigation being initiated on the nitrogen content in young grass. Normally, nitrogen treated grass at three-five weeks' growth, contains about 88 per cent. of protein nitrogen. This investigation is taking place at Jealott's Hill, but sufficient data are not yet available to come to definite conclusions. It would appear, however, that a certain time is necessary for the nitrogen of the manure to become elaborated into protein. This period seems to vary with the time taken to achieve a certain growth, and it would appear that the more rapid the growth, the higher is the inelaborated nitrogen. Thus from the practical side, due care should be taken not to stock immediately after a very rapid period of growth. Two other cases of supposed nitrate poisoning with sheep were reported following an application of nitro-chalk. To test this, a lamb was fed with 10-oz. of nitro-chalk in nine days, and its health was in no way impaired. The urine contained large quantities of nitrate nitrogen, but there were no traces of blood. Part of

the nitro-chalk was fed in one dose of 3-oz. with no disturbance of health. Another lamb was fed with ¼-oz. nitro-chalk daily for 14 days. It ate its ration containing this and showed no signs of ill-health. It would appear from this that nitro-chalk is in no way harmful to sheep.

The importance of pasture products, and consequently pastures themselves, is so great that one need hardly stress it. It is, however, only within the last few years that any effort has been made to co-relate the work done in the different sections of it. Hitherto, the whole of the work has been done by soil chemists and botanists, but more recently the biochemists and physiologists have been enlisted. The last mentioned "are interested not in pasture as such, but in the effect of different types of pastures on the nutrition of the grazing animal. They are studying the chemical composition of the herbage to determine to what extent this can be co-related with its feeding value" (Orr). This side of the investigation has tended to be centered at the Rowett Institute, while the nutritional aspect of good pastures tends to be centered at Cambridge. Aberystwyth, while mainly tackling the botanical side, has also done some work in co-relating chemical and botanical positions. What I have said hitherto has related almost entirely to what might be classed as good permenent pastures, but before closing I should like to make some reference to the work which has been done at Rowett Institute. The work of this Institute concerns itself with what might be termed abnormal pastures, that is, pastures on which, on account of some lacking feature, animal growth is abnormal. The main feature in equally bad abnormal cases would appear to be a deficiency of one or more of the mineral constituents. To illustrate this, I append three analyses of different pastures :—

| — | Very high-grade pastures | Normal good pasture. Average 24 samples | Poor pasture (Falkland Islands). Average 55 samples |
|---|---|---|---|
| Silica-free ash | 8·68 | 6·64 | 4·56 |
| $CaO$ | 2·473 | 1·00 | 0·29 |
| $P_2O_5$ | 0·997 | 0·74 | 0·54 |
| $Na_2O$ | 0·698 | 0·25 | 0 31 |
| $K_2O$ | 2·398 | 3 18 | 2·20 |
| Cl. | 0·498 | 0·95 | 0·70 |
| N. | 3·562 | 2·83 | 1·95 |

From available figures it would appear that "rate of growth of the young, percentage fertility, and health, are roughly parallel with the percentage of silica-free ash". In the worst case given above, the figures given were lambs born, 90 per cent., surviving at dipping, 52 per cent. Other figures go to show that there is a definite co-relation between minerals and protein, and that pastures low in minerals tend to be low in protein. It is, however, only in cases where there is an extreme deficiency of one or other minerals that mineral deficiency diseases occur. Thus far, the study of mineral deficiency has been mainly in connection with calcium and phosphorus, but a certain amount of work has also been done on iron and iodine. It is possible, however, that very small deficiencies of other minerals may yet be found to be of equal importance in some cases. I do not intend to go further into this subject, but would refer any one who is particularly interested to Dr. Orr's book on "Minerals in Pasture," which summarises the work which has been done to date.

## DISCUSSION.

Mr. J. R. BOND commenced the discussion and called attention to methods of seeding down, stating that new pastures now were generally of greater value than old. He also drew attention to hoof cultivation in dealing with matted turf and mechanical cultivation design to lacerate the mat. He thought that there was danger of diseases appearing in stock by the greater stocking of pastures.

Mr. A. LEVIE raised the question of why soap works lime acted best, and suggested that there might be present some alkaline matters more soluble than lime. He also drew attention to the need for mixed stock on pasture land.

Major T. V. BAGSHAW raised the question of hoof culture.

Mr. P. M. EVERSHED said that there were more and more cases of milk fever and questioned whether this might not be due to lack of lime in the soil.

Mr. E. WILKINSON expressed the view that there was great value in liming to prevent milk fever. On fields belonging to a certain farmer which had had ample dressings of lime there had been no milk fever, whereas there had been many cases on others in the neighbourhood.

Mr. W. J. IRONSIDE called attention to parasitic diseases due to the over-stocking of pastures and also mentioned the case of strong pastures.

Captain O. V. GUNNING thought that continuous milk selling might have some detrimental effect on the pastures. He asked why aftermath caused scouring.

In his reply, Mr. DICKSON said that a good many of the troubles of strong pastures were due to low fibre content. He had not had much experience with regard to milk fever and wondered whether a wet season might not have a great deal to do with it. Lime was not needed where acid was due to a mat. Certain ordinary fields scoured young stock after a rapid growing time. Aftermath was high in fibre, low in protein and carbohydrates.

# LUCERNE.

BY

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*Military Farms Department, India.*

(Reprinted from a pamphlet issued under the authority of the Master General of Supply in India.)

*Description.*—Lucerne (*Medicago sativa*) is a leguminous plant, belonging to the same family as beans, peas and clover. It is characterized by a distinct tap-root which in suitable soils extends to a considerable depth and which has few to many branch roots. Close to the surface of the ground, the plant has a semi-woody base, known as the " Crown ", from which arise the erect stems, which commonly reach a height of 2 feet and are not usually more than 1/8th-inch in diameter. The leaves are arranged alternately on the stem and like clover are in threes. The plant has racemes of purplish flowers in loose branches. The seed is produced in pods which are twisted spirally, each pod containing several kidney-shaped seeds, often somewhat mis-shapen.

*Soil and Climate.*—Lucerne is not a crop that will succeed on all soils and in all climates. It prefers a soil containing a considerable percentage of lime, but good crops are grown on clays and loams, where the climate is dry and warm. The tap-root descends to a great depth and the plant is thus enabled to resist severe drought. On soils in need of drainage, it will not succeed and both surface and underdrainage are necessary if lucerne is to thrive.

*Preparation of Seed-Bed.*—In establishing a lucerne stand, the first essential is correct preparation of the seed-bed. While this presents no great difficulty, it is remarkable how indifferently lucerne land is usually prepared, particularly in view of the cost of the seed and the time the stand is to last. For these reasons thorough tillage operations are probably more essential for lucerne than for any other main crop.

It is absolutely essential, if the satisfactory establishment of lucerne is to be obtained, to have the land in good heart, free from weeds and with adequate moisture at seeding time. The subsoil must be well-drained, and if there is the slightest danger of a shortage of lime, this must be made up before sowing.

In order to obtain the necessary conditions for satisfactory growth, the preparation of the land should be put in hand several months before sowing. The initial ploughing should be deep and be followed by the harrow if the ground be in a cloddy condition.

The soil should be in good tilth to induce the germination of weed seeds on the fallow and then to destroy them, when very young, by means of harrow or tine

cultivators. These cultivations should only be made to a shallow depth and *reploughing should be avoided*, with the object of destroying as many weeds as possible in the top few inches of the soil, without turning up fresh weed seeds from the lower soil. It is impossible, even with a twelve months fallow, to rid the soil entirely of weeds, if fresh weed seeds are continuously brought up by deep cultivation or reploughings. As there is always great risk of weeds coming up on the land and smothering the young crop out before it is established, the success of the operations undertaken to keep down weeds is therefore of prime importance.

The cultivations which are necessary to control weed growth, if done correctly, should result in a fine seed-bed, well supplied with moisture at sowing time.

These conditions are essential to ensure good germination of seed, which should be plump and of good quality. Very little soil covering is required, deep sowing being particularly responsible for poor germination.

*Method and Time of Sowing.*—Lucerne in India is usually sown without a nurse crop. It can either be sown broadcast, on flat beds or in lines, and the last method has generally proved superior, particularly under canal irrigation. When sown in lines, the crop can be kept much freer from weeds, and intercultivation can be practised.

The rows should be about 12 inches apart, and a seed rate of from 15-25 lbs. per acre, is sufficient.

Sowing can be carried out either in February, March or in September, but in the former case it is essential to get the crop well established before the hot weather.

*Manuring.*—The manurial requirements of lucerne are mainly phosphates and potash, while the necessity of an adequate supply of lime has already been mentioned. Nitrogenous manures are not required.

Farmyard manure, on account of its introducing weed seeds, should never be directly applied to lucerne. If the application of this manure is necessary to bring the land into good heart, it should be applied well-rotted to the crop grown on the land before the fallow.

If the soil is not naturally rich in lime, 10 to 20 cwts. of ground lime per acre should be applied before sowing the seed, or 2 to 3 tons may be used for a preparing crop. In India it is probably a sound practice to always apply a dressing of lime before sowing.

As regards potash, the need for this is largely dependent on the class of soil. On a clay soil no potash will be required, while on light soils the addition of ¾ cwt. of sulphate or muriate of potash per acre may prove beneficial. Basic slag is usually considered preferable to superphosphate, mainly on account of its lime

content, but in the only records which we have available, *i.e.*, those at Ferozepore superphosphate definitely proved its superiority.

The usual dressing recommended is from 2-3 cwts. per acre annually or 5 cwts. in alternate years. The Ferozepore results however seem to indicate that a dressing of 3 cwts. produces results for two years.

Where lucerne has not been grown previously, the proper nitrogen-collecting organism (*B. radicicoli*) may either not be present or be insufficiently active.

The preparation of cultures for inoculating the seed has been successfully achieved at Rothamsted, but a good way of getting a stand on fresh ground is to scatter over it soil from a successful lucerne field. This method may become expensive, and recently it has been found that if a small quantity of soil is mixed with the seed and drilled at the same time very successful results are obtained.

*After-treatment.*—The main aim of after-treatment is to keep down weeds and to continually stir the soil. The rigid tined or spring tooth cultivator should be used several times throughout the growing season, and particularly towards the end of the cold weather, followed by a dressing of artificials if due.

Damage to the crown of the plants may result from the use of disc implements, and they are not recommended. The timely use of cultivating implements will result in cleaner crops by destroying weeds and heavier yields by conserving moisture and aerating the soil.

*Time to Cut.*—Until the plants reach the flowering stage in the first year they should not be cut, as too early cutting checks the development of the tap-root, which is all-important, and weakens the plants, so that they are unable to compete against weeds. It is also advisable to leave about 4 inches of the plant when taking the first cutting.

A considerable amount of investigation has been carried out in America as to the best time to cut lucerne, and the general consensus of opinion favours the early bloom stage.

In Ohio damage to the stand was observed from cutting too early before first bloom or from cutting too late after the crop was too mature. In Wisconsin early cutting thinned the stand, weakened the plants, and permitted the encroachment of weeds. Cutting off crown shoots, contrary to common opinion did not injure the stand. Similar observations by other authorities all pointed to the fact that too early cutting is accompanied by great danger to the stand.

In Iowa the time recommended for cutting is when one-tenth to one-fourth of the crop is in bloom, while Hunt in "Forage and Fibre Crops" recommends when from one-tenth to one-third of the total flowers are formed. He adds

that the crop should be cut as soon as the lower leaves turn yellow, regardless of the stage of bloom.

Stands of lucerne in India are generally difficult to maintain for more than three or four years. The general tendency to cut too early and too often is probably partly responsible for this, as the stand becomes thin and weakened and unable to stand the hot winds.

Lucerne should never be grazed the first year and only slightly the second year, as a good take can easily be ruined by over-grazing. The plants should never be grazed so closely that the crown is injured.

*Irrigation.*—The usual tendency is to over-irrigate lucerne, in which case the root-system is typical, consisting of the main tap-root with very few laterals and fibrous rootlets. Any approach to water-logging is fatal.

To ensure full yields lucerne requires an ample supply of water and if possible, the soil should not be allowed to dry right out between irrigations. "Little and often" is far preferable to heavy and infrequent applications of water.

To ensure the proper distribution of water, and the development of even crops, the fields must be level and without hollows where water can collect.

*General.*—Once established, lucerne should stand for a number of years, provided it is properly treated, and should only be broken up, when the weeds get so bad that they threaten the progress of the crop.

Immature lucerne, like most legumes, is very intolerant of *Kallar*, but mature lucerne is fairly tolerant. On such soils, the effect of a good stand of lucerne, where the tap-roots have penetrated deeply into the soil, is most marked on subsequent crops.

*Manurial trials.*

Each plot 1 acre.

Military Grass Farm, Ferozepore.
Manager—Sub-Conductor J. W. Vining.

Five acres of lucerne which had been done for two to three years were selected for experiment.

No artificials had been previously applied. The lucerne had been broadcasted.

Artificials were applied as under—

Plot No. 1.—3 cwts. superphosphate.
Plot No. 2.—3 cwts. superphosphate, ¾ cwt. muriate of potash.
Plot No. 3.—3 cwts. basic slag, ¾ cwt. muriate of potash.
Plot No. 4.—3 cwts. basic slag.
Plot No. 5.—¾ cwt. muriate of potash.

The artificials were applied in March 1927. The results were as follows.

| Date of cutting | Plot No. 1 super-phosphate alone | Plot No. 2 super-phosphate and potash | Plot No. 3 basic slag and potash | Plot No. 4 basic slag alone | Plot No. 5 potash alone |
|---|---|---|---|---|---|
| | lbs. per acre | lbs. per acre | lbs. per acre | lbs. per acre | lbs. per acre |
| 7th May 1927 . . . . | 9,200 | 7,500 | 7,620 | 7,400 | 7,180 |
| 3rd June " . . . . | 6,620 | 6,350 | 6,540 | 6,450 | 6,700 |
| 3rd July " . . . . | 6,720 | 5,250 | 6,200 | 5,900 | 6,000 |
| 24th July " . . . . | 7,950 | 6,720 | 7,630 | 7,200 | 7,150 |
| 26th August 1927 . . . | 8,560 | 6,890 | 7,840 | 7,600 | 7,500 |
| 6th October " . . . . | 7,200 | 5,200 | 4,950 | 5,950 | 5,698 |
| Total . | 46,250 | 37,910 | 40,780 | 40,500 | 40,228 |

| Date of cutting | Plot No. 1 superphosphate alone |
|---|---|
| | lbs. per acre |
| 4th November 1927 . . . . . . . . . . | 6,100 |
| 10th December 1927 . . . . . . . . . . | 6,400 |
| 30th January 1928 . . . . . . . . . . | 7,900 |
| 4th March 1928 . . . . . . . . . . | 9,350 |
| Total . | 76,000 |

The superiority of superphosphate over other treatments, *i.e.*, an increase in six cuttings of 5,470 lbs. over the next best plot, *i.e.*, No. 3, was marked and the further cuttings, four in number, taken up to 31st March 1928, were weighed separately.

The total outturn of this acre amounted to 76,000 lbs. green.

It was decided to apply superphosphate at the rate of 3 cwts. per acre to all lucerne. All fresh sowings were made in lines 12 inches apart. 10 cwts. of ground lime per acre were applied previous to sowing and superphosphate applied after taking the first cutting. Eight acres were sown between 10th March and 10th April, 1927.

The outturn of 11 acres (8 sown as above and 3 broadcast retained), from the period 1st April, 1928 to 15th November, 1928, from which six cuttings were taken, amounted to 5,08,635 lbs. equivalent to 46,239 lbs. per acre in 7½ months.

The outturn of 12 acres broadcast and to which no artificials had been applied for the period 1st April, 1925 to 31st March, 1926, amounted to 4,35,758 lbs. equivalent to 36,313 lbs. per acre in 12 months.

The application of superphosphate enabled the lucerne to stand up to the hot winds before the rains, gave increased weight per cutting, and also increased the number of cuttings taken.

Sowing in lines enabled the crop to be continuously intercultivated, which was thereby kept much cleaner.

*Trials with imported lucerne.*

Military Grass Farm, Ferozepore.

Manager—Sub-Conductor J. W. Vining.

It was decided to carry out experimental trials with certain varieties of imported lucerne to see whether larger acre outturns could not be obtained as compared with the variety usually grown, the seed of which was obtained from Neemuch.

Seed of the following varieties were obtained :—

Giant Upland from Messrs. Yates & Co., Sydney, Australia.

French Provence
Spanish Aragon
Spanish Tamata
Grimm
} through Messrs. A. & G. Leighton Ltd., Newcastle, Staffs, England.

These varieties were sown between 19th and 22nd November, 1927. The land having previously received a dressing of 10 cwts. of ground lime per acre, and after the first cutting had been taken, superphosphate was applied at the rate of 3 cwts. per acre.

| Variety | Area | 1st. 7-2-28 | 2nd. 1-4-28 | 3rd. 1-5-28 | 4th. 21-6-28 | 5th. 24-7-28 | 6th. 20-9-28 | 7th. 10-11-28 | Total | Acre equivalent |
|---|---|---|---|---|---|---|---|---|---|---|
| | acre. | | | | | | | | | lbs |
| Giant Upland . | 1/4 | 1,750 | 2,790 | 2,520 | 1,400 | 1,800 | 2,250 | 2,530 | 15,040 | 60,160 |
| Grimm . . | 1/3 | ... | 4,758 | 3,300 | 1,820 | 1,900 | 2,300 | 2,460 | 16,538 | 49,614 |
| Provence . . | 1/3 | ... | 3,155 | 2,890 | 2,010 | 1,860 | 2,140 | 2,240 | 14,295 | 42,885 |
| Spanish Aragon . | 1/6 | 1,080 | 1,5 7 | 1,350 | 680 | 1,000 | 1,460 | 1,420 | 8,560 | 51,360 |
| Spanish Tamata | 1/6 | 935 | 1,215 | 1,250 | 915 | 900 | 1,250 | 1,150 | 7,615 | 45,690 |
| Neemuch . . | 1/4 | 2,230 | .. | 2,110 | 1 295 | 1,400 | 1,600 | 1,700 | 10,335 | 41,[illegible]49 |

All varieties gave better results than the Neemuch Variety in this trial, the order of merit being (1) Giant Upland, (2) Spanish Aragon, (3) Grimm, (4) Spanish Tamata, (5) Provence, (6) Neemuch.

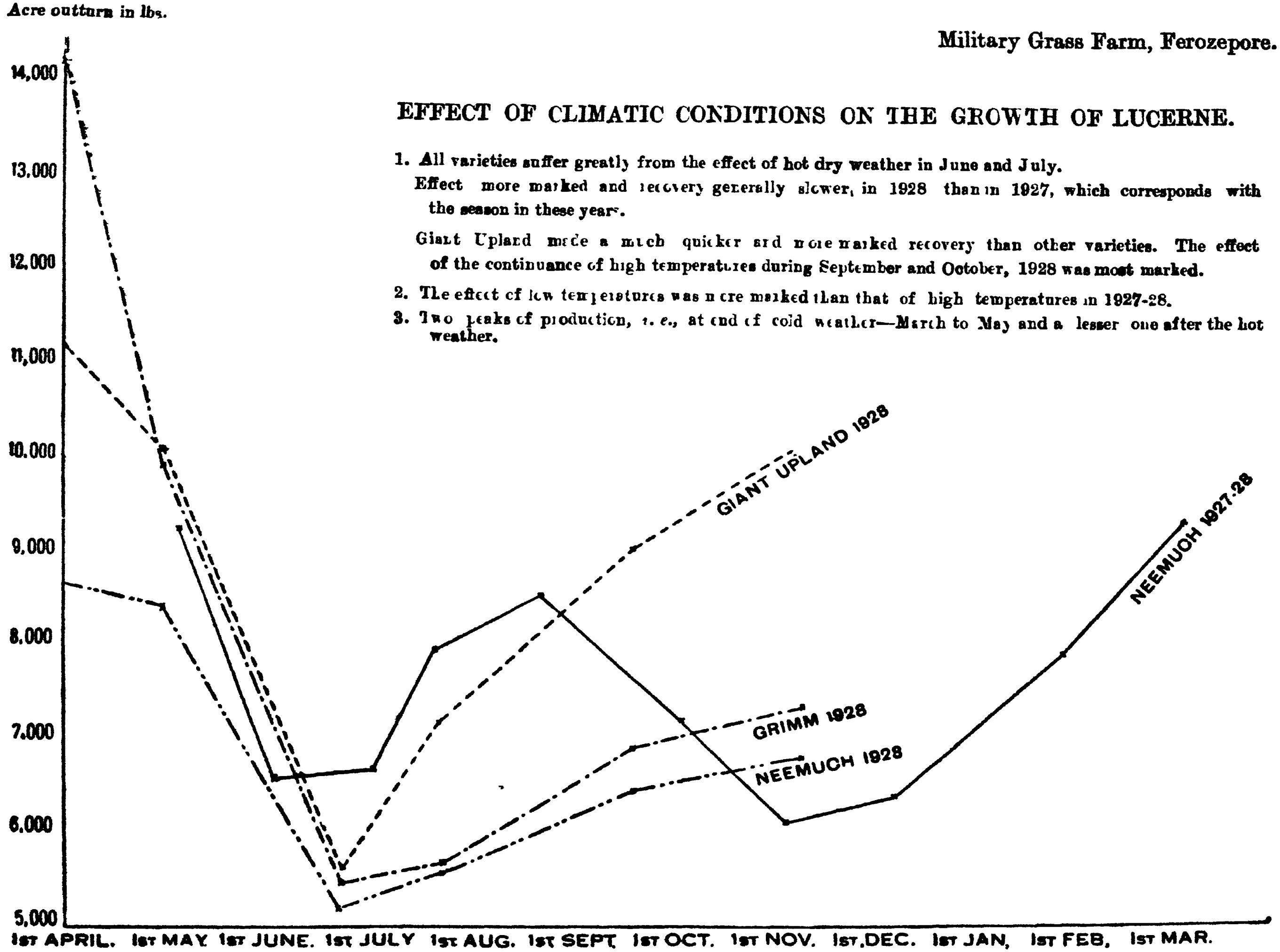
The yields of both Giant Upland and Spanish Aragon were extraordinary for the first year. No lucerne was cut for the first time until it commenced to bloom which accounts for no cutting being taken from Grimm and Provence until 1st April 1928, both these varieties were slow in establishing themselves but later grew well.

Military Grass Farm, Ferozepore.

## EFFECT OF CLIMATIC CONDITIONS ON THE GROWTH OF LUCERNE.

1. All varieties suffer greatly from the effect of hot dry weather in June and July.
   Effect more marked and recovery generally slower, in 1928 than in 1927, which corresponds with the season in these years.

   Giant Upland made a much quicker and more marked recovery than other varieties. The effect of the continuance of high temperatures during September and October, 1928 was most marked.
2. The effect of low temperatures was more marked than that of high temperatures in 1927-28.
3. Two peaks of production, *i. e.*, at end of cold weather—March to May and a lesser one after the hot weather.



# ENSILAGE-MAKING METHODS.

**The pit compared with the stack at Stratford Demonstration Farm.**

BY

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(Reprinted from the *New Zealand Journal of Agriculture*, Vol. 41, No. 3.)

With a view to introducing the pit method of conserving ensilage a concrete hillside pit was built at the Stratford Demonstration Farm during the season of 1929-30. In common with the position on the majority of farms in the Stratford district, where the country is slightly broken, several suitable sites were available. The main points about a site for a hillside pit are, firstly, proximity to the paddocks where the crops are to be saved and to those where feeding-out is to be done; and, secondly, the securing of a hillside with sufficient depth and with good access and exit to and from the pit-bottom. This latter point is very important, as practically the whole of the carting out is done during the winter months, when with heavy loads of ensilage, the cutting-up of the roadway will be considerable.

A very suitable site conforming to both of these conditions was selected on the farm. The area of land that can be called on to fill the pit is about 30 acres, while the pit-bottom strikes a conglomerate material that in itself makes a very suitable road. In this instance it was possible to have one road leading in and another leading out, both with good grades. The matter of having two roads is not so important, provided there is sufficient room at the pit-bottom to turn and that there is a good grade out. The two roads are an advantage, however, as turning with a wagon at the pit-bottom means a good deal of wear-and-tear even on a well-metalled road. The advantage of having a pit built on a hillside is that it minimizes the actual handling of the green material and the finished ensilage. There is no undue lifting, as each operation means handling the stuff *down*. An opening, 4 ft. in width, the whole depth of the pit, with the exception of the top 4 ft., is left on the side of the pit looking out from the hillside, and through this opening the ensilage is taken out during the feeding-out process. During the filling of the pit the opening is boarded up as the pit is filled, the boards being rabbeted together and so made perfectly airtight.

### CONSTRUCTING THE PIT SILO.

In building, the pit was first bored out to the prescribed size, which in this instance was a circle 20 ft. 8 in. diameter to a depth of 14 ft. The walls were kept perpendicular. On the inside of the pit was built a wall or lining of concrete 4 in. thick. Only one set of boxing some 3 ft. in depth was required, which set completed a ring round the pit. No boxing is required for the back of the concrete as the solid earth wall is sufficient. Buttresses some 6 in. in thickness were built on either side of the opening to give strength to the structure, for at this point there is no earth wall to support the concrete; these buttresses are 3 ft. wide. No reinforcement was used, except for 10 ft. back on either side of the opening and for the buttresses. The pit was brought some 2 ft. 6 in. above ground-level, and a great deal of the spoil from the excavations was used to form a ramp up to this height to allow the sweeps to work right up to the edge of the pit. The ramp was graded off to some 15 ft. back from the pit, and this rise of 2 ft. 6 in. in 15 ft. presented no difficulty for sweeping. A removable lean-to roof of wood and iron was constructed in three sections, and has a fall of 1 in 40. The sections were bolted to three plates, which in turn were bolted down to the concrete of the pit. Two men can remove the roof without great difficulty.

After due consideration it was decided to have the pit built by contract, and tenders were called for the job. The tender accepted was in the vicinity of £100, but this cost included the excavations and roof as well as the concreting. In most cases a farmer would do his own excavation work, and, provided he had the boxing, the concrete work would present no difficulty; so that a similar pit could be built at a much reduced cost.

### MAKING THE PIT ENSILAGE.

A start was made with the filling of the pit early in December. The procedure followed was for one man to begin mowing when the others started milking in the morning, and to cut till breakfast time. After the routine work, such as washing up and cleaning the milking-shed, had been completed a start would be made with the ensilage. One man would operate the sweep, working so that he would bring in a load from near the pit and then one from much further afield. This gave the men at the pit more time to handle the material. A second man was stationed at the top of the pit, his duties being to pull the sweep load to pieces and fork it into the pit. From the top of the pit where the sweep left the load it was possible for this man to feed the green material right to the builder, and this saved a further man in the pit. The builder, receiving the material in small forkfuls, was able to make a good job filling, and the material was evenly distributed—not in rolls as one sometimes sees it. Careful building in the pit is just as

essential as it is in the stack, if first-class ensilage is to be made. The centre of the pit was kept high in building, and due attention was given to the walls. Filling was commenced on 9th December, and continued on the 16th, 20th, 24th and 27th from 5 ft. to 6 ft. of material being put in on each occasion. When the last lot of green material was added the mass was some 6 ft. above the top of the pit, and it was nearly a fortnight before it had subsided enough for the roof to be put on.

The top of the ensilage was not weighted in any way, although it is common practice to put about a foot of soil on, as is done with ensilage stacks. The idea was to determine just how much waste would occur without any weight, and to get some idea as to whether the labour incurred in topping would be compensated for in the reduced waste that should occur. Taking everything into consideration, the result of this trial proved that leaving the stack without any weight is not a payable proposition. The waste on top averaged about 6 in. all over, which would represent about 3 tons of ensilage, while to the depth of about 2 ft. the ensilage ranged from dark to light brown, which is of slightly inferior quality to the green. Below this depth the ensilage was of splendid quality, being almost as green as the day it was saved and slightly sour.

### Stack made for Comparative Purposes.

In order to get some idea of the saving effected by the pit silo as against the stack method of conserving in regard to labour, waste, etc., a stack was built in an adjacent paddock at the same time as the pit was being filled, and all details of labour, etc., were accurately kept. This stack was commenced on 14th December and completed on the 23rd, after six days' building. As against three men employed on the pit it was necessary to have four men and a boy working on the stack—one on the sweep, one at the stack-bottom, two on the stack, and a boy to lead the horse of the hoist. The size of the stack was 18 ft. by 20 ft. and was 6 ft. in height when it had finally settled down. The estimated weight of ensilage in the stack was 50 tons, as against 85 tons in the pit. The actual time worked on the stack was $150\frac{1}{2}$ hours, while the filling of the pit occupied 125 hours The boy's labour for leading the horse was reckoned as half of that of a man. Basing the labour at 2*s*. 6*d*. per hour the cost of labour for the stack was £18 16*s*. 3*d*., or 7*s*. 6*d*. per ton, as against £15 12*s*. 6*d*., or 3*s*. 8*d*. per ton, for the pit. The number of hours for the pit includes the time estimated for topping up with soil, had this work been carried out. Assuming, then, that the stack contained the same quantity of ensilage as the pit—85 tons—the total labour cost would then be £31 17*s*. 6*d*. for the stack and £15 12*s*. 6*d*. for the pit, or a saving of £16 5*s*. in favour of the pit. In addition to this no allowance has been made for the extra horse that was required for the purpose of working the hoist.

### Advantage lies with the Pit.

The actual waste on the stack was 1 ft. deep on all the walls and about 1 in. at the top. This estimate of wall wastage is on the conservative side. The wall wastage in the pit would not exceed 2 in. and as labour for topping up has been reckoned in the case of the pit it is only fair to assume that the wastage would have been the same as that of the stack, namely, 1 in. on top. Reckoning the weight of ensilage at 45 lbs. to the cubic foot, it is found that the total waste in the case of the stack is 9 tons 15 cwt., or 19·5 per cent., while in the case of the pit it is 3 tons 8 cwt., or 4 per cent. Again, assuming that the stack contained 85 tons the waste could be reckoned as 16½ tons, as against 3 tons 8 cwt. for the pit. Putting the conservative value of £1 per ton on the ensilage, the value of the waste material in the case of the stack would be £16 10*s*., as against £3 8*s*. for the pit, or a saving of £13 2*s*. on the pit. Thus the total saving in favour of the pit is £16 5*s*. for labour and £13 2*s*. for wastage, a total of £29 7*s*. As an offset against this could be reckoned interest on the capital cost of the pit—say, £7—and depreciation—say, £2—leaving a net saving of £20 7*s*.

Thus it will be seen that, given a suitable site, the construction of a pit is a very payable proposition. In addition to the actual saving of over £20 there must be reckoned the ease with which the material is handled—less human energy being required—and the fact that building in the pit presents no very great difficulties, also that once the ensilage is saved it can be kept indefinitely in the pit.

# FEEDING OF FARM CATTLE.

BY

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Three points should be uppermost in the mind of a stock-feeder:—(1) quality of ration, (2) quantity of ration and (3) economy of feeding. Too much of any concentrates or of any bulky foodstuff as well as too little of these will only impair the productivity of the stock and thus affect the financial position of live-stock enterprise. The ration should therefore be of the best quality as well as of the optimum quantity in order to obtain maximum net returns as could be obtained through the most judicious system of rationing. The best quality and optimum quantity in a ration together constitute what is termed as "balanced ration". By analysing and augmenting these three most fundamental points, we should find the following essentials of an ideal ration:—

(1) The balanced ration should contain most appropriate quantity of—

- (*a*) Starch equivalent (S. E.) for maintenance.
- (*b*) Ditto production.
- (*c*) Digestible proteins (D. P.) for maintenance.
- (*d*) Ditto production.

(2) It should possess an appropriate amount of bulk (dry matter)

(3) Ditto (mineral matter).

(4) It should not be lacking in any of the vitamins.

(5) It should have good taste and aroma to be sufficiently palatable.

(6) It should be free from such ingredients as would either affect the growth and health of the animal or the quality or quantity of its products; and finally,

(7) It should be most economical.

### BALANCED RATION AS REGARDS FOOD CONSTITUENTS.

The starch equivalent ( S. E. ) of a feeding stuff may be defined as the number of pounds of pure starch that the animal would require to digest in order to supply the same quantity of net energy as 100 lbs. of the feeding stuff in question.

The system of starch equivalents gives the actual net energy value in a single figure for each feeding stuff. Starch equivalent varies according to the type of the animal that consumes it.

*S. E. for Maintenance.*— It has long been proved by definite experiments that cattle of 1,000 lbs. live weight require 6 lbs. of S. E. for maintenance, that is to say, to supply (*a*) heat to keep up the body temperature, (*b*) energy to do the internal work and (*c*) materials to make good the ordinary wear and tear of the body without causing an increase or decrease in live weight. Mere maintenance ration keeps the animal at a fixed live weight or in a state of non-production. Further, maintenance ration is proportional not to the body weight but to the area of the body surface; and since the body surface varies as the two-thirds power of the live weight, the formula for determining the maintenance requirement would be

$\left(\frac{\text{Actual live weight}}{1,000}\right)^{\frac{2}{3}} \times 6$. However, to avoid the trouble of reducing this intricate formula to a single figure, the writer, deducing from a plotted graph suggests as follows :—

(*a*) for every lb. above 1,000 lbs. live weight (L. W.) up to total L. W. of 1900, add ·04 lb. of S. E.

(*b*) for every lb. below 1,000 lb. L. W., deduct roughly ·036 lb. of S. E. The formulae which require very little calculation will therefore be as follows :—

1. for animal weighing 1,000 lbs., give 6 lbs. of S. E.
2. for animal weighing above 1,000 lbs., give 6 + (1,000—actual L. W.) × ·04 lbs. of S. E.
3. for animal weighing below 1,000 lbs., give 6—(1,000—actual L. W.) × ·036 lbs. of S. E.

*S. E. for Production.*—Production in cattle may be of any of the following types :—

1. Growth of foetus.
2. Growth of young animal.
3. Fattening.
4. Milk yield.
5. Work of draught.

The following figures give approximate quantities of S. E. necessary for units of production.

*Growth of foetus.*—Give 1 lb. S. E.

*Growth of young animal (without fattening).*

| | | | | | |
|---|---|---|---|---|---|
| at the age of— | | | | | |
| 0-3 months | 1¼ lb. S. E. per lb. L. W. increase. | | | | |
| 3-6 „ | 1½ | „ | „ | „ | „ |
| 6-12 „ | 2 | „ | „ | „ | „ |
| 12-24 „ | 2½ | „ | „ | „ | „ |

*Fattening.*—In India fattening of cattle is not in vogue as a rule, nor does it ever constitute a primary industry. However, when the cattle have ceased to produce economically in other directions they are sometimes fattened off before they are sold to the butcher.

The following amount of S. E. may be given for the purpose of fattening :—

| | | | | | |
|---|---|---|---|---|---|
| Early stages | 2½ S. E. per lb. L. W. increase | | | | |
| Last stages | 3½ | „ | „ | „ | „ |
| Average of the whole period | 3 | „ | „ | „ | „ |

*Milk yield—*

| Quality of milk (fat percentage) | S. E. per lb. of milk yield. | |
|---|---|---|
| 3·5 to 4 | ·25 | |
| 5 to 5·5 | ·30 | |
| 6 to 7 | ·35 | tentatively suggested. |
| above 7 | ·4 | |

*Work of draught.*—Since no accurate measure of work is available it is impossible to suggest any satisfactory figures of S. E. per unit measure of work. However, the following figures (Watson, J. A. S. and More, J. A.) may be taken into consideration.

| Severity of work. | The S. E. per 1,000 lb. L. W. for every hour wrought. |
|---|---|
| Light work (carting, interculturing, etc.) | 1 |
| Heavy work (ploughing, lifting water, etc.) | 1·25 |

*D. P. for maintenance.*—The maintenance requirement of protein is proportional to the live weight, although different proteins are not of equal value. A deficiency in any "building stone", *e.g.*, tryptophan will act as limiting factor and, in order that it should be supplied in due quantity, larger amount of protein is required to be supplied in order to maintain the balance. A rough minimum,

however, for cattle on an ordinary mixed diet has been suggested as ·06 lb. of D. P. per 100 lb. L. W.

*D. P. for Production.*—The following figures give approximate amount of D. P. necessary for units of production :—

1. *Growth of foetus :—*

   ·03 lb. D. P.

2. *Growing young animals :—*

   at the age of—

| | | |
|---|---|---|
| 0-6 months | 0·22 lbs. | D. P. per lb. L. W. increa e. |
| 6-12 „ | 0·20 | „ „ „ |
| 12-24 „ | 0·18 | „ „ „ |

3. *Fattening :—*

| | | |
|---|---|---|
| Early stages | 0·15 lbs. | D. P. per lb. L. W. increase. |
| Last stages | 0·05 | „ „ „ |

4. *Milk yield :—*

| Quantity of milk (percentage of fat) | D. P. per lb. of milk yield. | |
|---|---|---|
| 3·5 to 4 | ·055 | |
| 5 to 5·5 | ·066 | |
| 6 to 7 | ·077 | tentatively suggested. |
| over 7 | ·088 | |

## *A Suggestion for Future Work.*

The writer is conscious that although the principles given above look quite simple on paper, they are by no means easy to follow in actual practice, for reasons that S. E. or D. P. of many of the Indian farm products are not determined and that even some of the biggest farms in India do not possess any balance or similar contrivance to weigh the animals. To overcome these difficulties it would be an ideal and at the same time workable plan to co-relate age with average weight of each breed of cattle in the same tract with the same environmental conditions. Since this cannot be done by individual farmers, the Department of Agriculture of each Province should arrange to work out such co-relations for the benefit of the farmer. Departure from such average co-relative figures should either be negligible or exceptional if average of a large number of cattle which should really belong to a pure breed (and not heterogeneous) is made, when such co-relations are determined for each breed of a tract, it will be just a step further involving only a little

additional effort and expense on the part of the Agricultural Department to supply farmers with the following details tabulated as under :—

Breed.................Tract ................Average annual rainfall...........

| Age | Average weight | Ration for maintenance | | Ration for production | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Growth of foetus | | Growth of young animal per lb. L. W. increase | | Fattening per lb. L. W. | |
| | | S. E. | D. P. | S. E. | D. P. | S. E. | D. P. | S. E. | D. P. |

| Age | Average weight | Ration for production | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Per lb. of milk yield of fat percentage | | | | | | | |
| | | 3·5—4 | | 5—5·5 | | 6—7 | | Above | |
| | | S. E. | D. P. | S. E. | D. P. | S E. | D. P. | S. E. | D. P |

It should be borne in mind that the quantities and proportion of food constituents recommended above should by no means be taken as constituting the exact balance but merely a sort of most convenient form to begin the trials to adjust the ration. The following reasons show why mathematically definite ration cannot be recommended.

1. No two animals, however similar, can digest the same food to the same extent.

2. Digestibility of a food may also differ in animals of different ages.

3. Meteorological or environmental factors may also alter the digestibility of food stuff.

4. Digestibility of a feeding stuff has been determined by feeding the animal on one kind of food stuff alone. But there are evidences to show that in a mixture, one kind of food stuff may increase or decrease the digestibility of another.

5. Chemical composition of a plant and food may also vary according to the

(i) Age or maturity at which the plant or its products are obtained,

(ii) Variety or strain of the plant,

(iii) Manurial or cultural treatment,

(iv) Handling and condition of storage,

(v) Season, rainfall, etc., etc.

Hence judgment, deep study and proper management are the keys to the success of cattle enterprise.

### DRY MATTER.

For cattle the total bulk of the ration should not be below $1\frac{1}{2}$ per cent. of the live weight daily, nor should it exceed $3\frac{1}{4}$ per cent. The former figure should be taken in the case of animals on a maintenance ration, while the latter is applicable in the case of such animals whose production is exceptionally high. The writer believes that for average Indian cattle the ordinary sort of production ration should contain a quantity of dry matter equivalent to about $2\frac{1}{2}$ per cent. of the live weight. Since air-dry food stuff such as hay, *kadbi*, cereals, bran, cake, etc., contain on an average about 86 per cent. of dry matter, if the quantities of these equivalent to 3 per cent. of the L. W. be given it will make up $2\frac{1}{2}$ per cent. dry matter bulk. Similarly any succulent feed such as silage and green fodder in general, which contain on an average about 25 per cent. dry matter (except cabbages, turnips, etc., which are not fed as a rule in India) may be given in quantities equivalent to 10 per cent. of the L. W. in order to make up the required bulk. Thus to arrive at a correct figure of bulk of ration multiply the L. W. by ·03 in the case of air-dry food stuff alone and by ·1 in the case of succulents alone, and if the mixture of these is to be fed, then determine first the quantity of succulents per ration (for it is succulents that are required to be apportioned and not all the air-dry foods, most of which can be had all the year round) and then determine the quantity of air-dry food stuff according to the following formula of the writer :—

$$D = \cdot 03\ (W - 10S),$$

where D=air-dry foodstuff, W=L. W., &

S=Succulents.

*Example* :—A farmer has got 10 cattle of average weight of 950 lbs. each. He has at his disposal 10 tons of silage and 20 tons of *kadbi* which he has determined to feed for $7\frac{1}{2}$ months. How much of each should he apportion for each animal and how much of concentrates per animal should he feed in addition, in order to make up an appropriate bulk ?

$7\frac{1}{2}$ months = 224 days.

Days × number of cattle = No. of total feeds = 224 × 10 = 2240.

*Silage* (S).—

Total quantity in lbs. ÷ No. of feeds = No. of lbs. per feed.

= 22400 – 2240 = 10 lbs.

*Kadbi*—

Total quantity in lbs. ÷ No. of feeds = No. of lbs. per feed.

= 44800 ÷ 2240 = 20 lbs.

Total air-dry matter = D.

D = ·03 (W.—10 S) = ·03 [950—(10 × 10)] = 25·53.

*Remaining air-dry matter which will probably be concentrates.* 25·53—quantity of *kadbi* which has already been apportioned = 25·53—20 5·53 lbs.

## Mineral Matter.

Mineral matter is absolutely essential for the formation of bones in the growing animals, and for the secretion of milk in which it occurs as a constituent whose percentage being invariably the same, *viz.*, 75 per cent., acts as a limiting factor for the production of milk. It is also an essential constituent of blood and muscles and all the digestive secretions ot the body, and is responsible for giving tone to the physiological activities going on in the animal body. Its presence in the ration increases the digestibility of the latter and thus enables the animal to derive more energy and proteins than it would do without it. Mineral salts like sodium chloride render the food to the animal more palatable. Besides being absolutely essential for production, it is also required for maintenance of the animal, since continuous loss is taking place in the animal in the form of excretions, *viz.*, perspiration, hair, horn of the hoof and the dung. The dung derives its mineral matter from the secretions of the body into the alimentary canal.

Mineral matters that are likely to be wanting in required quantities in the ordinary ration are common salt, lime and phosphates. These may be administered in the following ways.

Common salt in crude form may be administered either mixed with ration or else by placing a lump or rock in some conspicuous situation in the byre so that cattle may help themselves to it by licking the same at their will.

Lime and phosphates may be administered either mixed with the ration in the form of ground phosphate rock, or meat, fish, blood or bonemeal in all of which

these ingredients are found in large quantities. These may also be supplied through feeding the crop richly manured with these. It may be remarked here that mineral matter administered as organic salts being more readily ionisable, is probably better assimilated than that as inorganic salts. Hence it is always a better and, at the same time, more economical method to feed lime and phosphates through manuring the food plant rather than mixing the same in the ration. Like balanced ration, recommendations as regards appropriate total quantities of lime and phosphates and the proportion in which these should be given, are also made by some workers both for maintenance as well as for production. But this is apt to make the whole system of rationing more complicated rather than easy. It will suffice to bear in mind that assimilation of CaO and $P_2O_5$ takes place in the proportion of 1 to 1 or in equal quantities, so that any quantity given in excess will not be assimilated.

## Vitamins.

Space does not permit to enter at length into the discussion about 'accessory factors' or 'Vitamins' which are quite recently distinguished to be of five types A, B, C, D, and E. Without any of these the animal cannot grow normally and be in a healthy condition, *e.g.*, absence of 'fat soluble A' brings about xerophthalmia; absence of 'water soluble B' gives rise to the beri-beri disease and that of C to scurvy, etc., etc.

The quantity of each of these vitamins required is really very small and the supply need not be continuous as reserve can be stored by the animals in their glands.

It will, however, suffice to bear in mind that deficiency of any of these vitamins would scarcely occur if ration for cattle contains variety of food, including fresh leafy portions of plants, for at least a part of the year in good amount.

## Taste and Aroma.

Cattle relish palatable food. Palatability increases the secretion of saliva and induces the animal to chew the food more efficiently with the consequence that its digestibility is increased. To increase palatability of a ration it is not necessary to add any condiments. On the other hand, to accustom the animal to the use of such substances should rather be avoided, except in case of fodder of inferior nature. Other things being equal, a ration which includes a variety of food stuffs is generally more palatable. Any food to which the animal has not been accustomed is likely to prove repulsive in the beginning, but on continued use and if introduced gradually this may be kindly taken to; otherwise its flavour should be masked by

better flavoured substances. Badly handled and ill-stored food, owing to the development of rustiness and rancidity, becomes less attractive. It should be remembered as a maxim that there is nothing more attractive to cattle than food stuffs that smell rather fresh. Very dry foods or meals with gritty particles may be made more palatable and appetizing by soaking in water before feeding.

### Freedom from Undesirable Ingredients.

Besides feeding value, palatability, etc., a food stuff requires to be judged on its merits or demerits of producing special effect immediately or in a cumulative manner on the general health of the animal, its particular physiological activities or quality or quantity of its products. For example, free use of treacle interferes with the breeding power. Decorticated cotton cake, if fed in excess, will bring about costive effect and is therefore more suitable in the beginning of monsoon when the flush of the green young grass brings about laxativeness. Palm kernel cake causes slight but apparently permanent increase in the percentage of fat. Cotton cakes, cocoanut cakes and bean-meal tend to give a hard butter, whereas linseed cake and fresh grass tend to make butter soft and greasy. Fresh grass, however, imparts a yellowish colour and hence its addition in ration in butter-making farm is important.

### Economy in Feeding.

Determination of appropriate quantities of food stuff and balancing of ration are in themselves attempts towards economy so that maximum net returns are obtained with the minimum cost of feeding. But there are a few other points that deserve to be considered here as well.

An animal whose total production is greater requires less food per unit of production than one whose total production is less. Within the same breed there is little difference in weight between a heavy producer and a low producer of the same ages. Hence the cost of maintenance part of ration is more or less the same in each case, irrespective of the amount of production. The cost of production of a part of a ration is however proportionate to the total amount of production. The cost, therefore, of maintenance, housing, attendance, care and management of an animal becomes less and less per unit of prodution as its total production increases.

In order to understand where economies can be most easily effected, it is essential to analyse the costs of production. Such analysis is however not available for India. But the following figures taken from the "Report of the Travelling

Commission of Enquiry into the cost of production of milk" for Great Britain show how the cost of producing a gallon of milk is distributed :—

| — | Winter per cent. | Summer per cent. |
|---|---|---|
| Cost of Foods (including grazing) | 72·0 | 53·0 |
| Cost of labour | 11·7 | 14·2 |
| Proportion of rents and rates | 1·4 | 2·1 |
| Depreciation— | | |
| (a) Cows | 10·0 | 21·4 |
| (b) Plant and machineries | 0·6 | 1·0 |
| Repairs and miscellaneous | 2·3 | 5·0 |
| Delivery (to station or buyer's premises) | 2·0 | 3·3 |
| | 100·0 | 100·0 |

These figures show that the cost of food is by far the most important single item, amounting on an average to almost two-thirds of the total annual cost. In India where the cost of labour and proportion of rent and rates are rather low when compared with the rest of the other items, and the grazing is rather limited, the cost of food may amount to as high as 80 per cent. or four-fifths of the total cost. But in the absence of reliable data it may tentatively be taken as a safe figure to the amount of about 75 per cent. or three-quarters of the total cost. Hence economy in feeding is much more important than the same in the rest of the items taken together.

Economy in the cost of feeding may be effected in four different ways :—

1. Evolving strains of better yield by breeding.
2. By having the ration well balanced.
3. By reducing the cost of production of home-grown food.
4. By purchasing the cheapest suitable food. The word "suitable food" is taken to mean as food possessing palatability, laxative or binding effect, mineral content, and either energy or protein whichever may be deficient. Purchasing food stuff on the basis of food unit system, though apparently seems quite all right, the proper method would be to purchase such food as contains the cheapest source of energy alone or protein

alone whatever may happen to be deficient in the home-grown food to give a balanced ration, and not necessarily of both of these. However, if deficiency of both is felt, then purchase cheapest kind of such food stuffs whose ratio of S. E. to D. P. corresponds to that in deficiencies.

Cost of transportation is proportional to bulk and not the quality. Hence it is advisable to grow as much of required quantity of bulk on the farm as will conveniently fit in with the cropping scheme. Another consideration should be to grow such crops whose cost of production per S. E. is least leaving out of count the cost of D. P., as the latter will either balance itself or if there be any deficiency, it will be comparatively so small and its quality rather so high that it can be purchased at no great cost. Besides, purchasing concentrates for the farm stock is better economical method of enriching soil with manurial constituents rather than application of the same to the soil direct.

NOTE.—S. E. for Indian food-stuffs under Indian conditions have not been determined, but these are computed from chemical analyses by Prof. Baluch, B.Ag., Manager of the Agricultural College Dairy.

# ABSTRACTS

## Some breeding Investigations on Toria and Sarson. ALI MOHAMMAD, RAM DHAN SINGH AND ZAFAR ALAM (*The Ind. J. Agri. Science*, **1**, 109).

In *Toria* and *Sarson*, two important Punjab oilseed plants, floral mechanism provides few chances for natural selfing. Under bag their flowers produce seed shyly, four years' average having given only 12·1 and 20·1 per cent. of pods respectively, and those too with greatly reduced seed-bearing portions, containing about 1/40th and 1/27th respectively normal seeds of those produced by free-flowering, insects-visited branches. Yellow-seeded *Sarson*, however, gives excellent setting under bag.

Artificial selfing in *Toria* and brown-seeded *Sarson* somewhat increased pod-setting. This increased production remained far short, however, of that given by free-flowering branches.

The high amount of self-sterility prevailing in these two plants is concluded to be due to internal causes, *i.e.*, self-incompatibility.

A cloudy, humid, rainy November affects *Toria* yields adversely, because in such weather insects do not come out to pollinate the flowers.

Due to lack of natural selfing and to self-sterility prevalence, lessened vigour was to be expected in both, from inbreeding. Direct evidence has verified this for *Sarson*. So must be the case with *Toria*. Therefore, in both pure lines as such do not promise direct economic utility. To obtain improved varieties, some sort of group-breeding must be followed.

In both, red-coloured seeds weigh less than blackish ones.

*Sarson* crosses readily with *Toria*, turnip and mustard, and *Toria* readily with *Sarson* and turnip. [A. M., R. D. S. and Z. A.]

## Studies in Indian Oil Seeds 5. The Inheritance of Characters in Linseed. F. J. F. SHAW, A. R. KHAN AND M. ALAM (*Ind. J. Agri. Science*, **1**, 1).

(1) The present study of inheritance of characters in linseed has established that the petal-colour in Indian types of linseed depends on the interaction of at least seven hereditary factors, and this is in general in agreement with the investigations of Tammes based on European types of linseed. The main difference consists in the action of the intensification factor A which according to our evidence is either homozygous in all our types or is altogether absent in them. We have further evidence to postulate an additional factor N which reduces the intensity of colour in petals. So far we have no evidence to split up the factor B into $B_1$ and $B_2$, and it is also considered that D alone (in absence of B) can produce faint blue tinge in the petals, if E is present.

In the study of all other characters our theories differ materially from those put forward by Tammes

(2) The crimped petals as noted in some of our types are produced by the interaction of three factors, namely, C, D and E, which determine petal-colour. The crimped petals appear only when all these three factors are present. In absence of any one of them, the petal is non-crimped. A fourth factor B stops the formation of crimped petals even when C, D and E are all present. In all the genotypes with B the petal is always non-crimped, irrespective of the presence or absence of other factors. This differs materially from Tammes' theory.

(3) Our theory on the development of colour in seed is again very different from Tammes. On our evidence the inheritance of colour in seed-coat is dependent on four separate factors, namely, D, M, G and X, one of which (*i.e.*, D) determines flower-colour as well. M, in the presence of D, converts the fundamental yellow colour into fawn, and, if G is also present, fawn is changed into brown. If, however, D is absent, M has no action and the fundamental "yellow" colour is retained. This yellow changes to "grey" on addition of the factor G; this will, of course, become brown when D is added to it. The factor X acts only as an intensification factor converting yellow into dark yellow and fawn into dark fawn. Its action on grey and brown seed has not been noted.

(4) The inheritance of colour in anthers is determined by the factors B and D (which also determine petal-colour) in addition to another factor H (as suggested by Tammes) for which all our types are homozygous. In this case we entirely agree with Tammes.

(5) In the case of the style also all our types appear to be homozygous, for the factor or factors which determine colour in this organ and hence in all our crosses the colour in style is determined by the presence or absence of some of the petal-colour factors, *i.e.*, B, C, K and E or F. Styles are blue only in those genotypes that possess those factors.

(6) The inheritance of colour in filaments is dependent on several Mendelian factors in addition to some of the petal-colour factors. Thus the colour in filament appears only when either of the duplicate factors $Z_1$ and $Z_2$ are present, and also the petal-colour factors B, C, K and E or F. Apart from the duplicate factors $Z_1$ and $Z_2$, an inhibitory factor T determines the extent of colour in it. In the presence of this factor the colour produced by $Z_1$ and $Z_2$ is limited to the distal end of the filament as it occurs in Type 11.

In connection with the study of inheritance of colour in filaments, styles and stigma, it may be noted here that crosses Nos. 1 to 8 were made from an economic point of view and hence they do not necessarily include the types which may be most valuable for a complete genetic analysis of Indian linseed. We have, however, established that the development of colour in these organs is dependent on definite Mendelian factors, which act in conjunction with some of the factors for petal-colour and that in certain types the development of colour is further controlled by inhibitory factors.

(7) The colour in stigma is determined by a factor P which produces pink colour only when the factors B and C are present. If D is also present the stigma-colour is purple. An inhibitory factor "I", whenever present, turns purple or pink stigma into white.

(8) About 80 new hybrid linseeds have been isolated from these crosses and the most promising types are being tested for yield and oil-content. [F. J. F. S., A. R. K. and M. A.]

## Osmotic and Suction Pressures of the Rice plant (*Oryza sativa* L.). R. H. DASTUR AND E. BAPTISTA (*Ind. J. of Agri. Science*, 1, 166).

The osmotic pressure of the roots and leaves of the rice plant during the whole season was measured by the plasmolytic method of de Vries, different molecular concentrations of pure cane sugar solutions being used as plasmolysing fluids. The osmotic pressure in all the regions of the plant showed a periodicity. As the season advanced, the osmotic pressure rose, reached a maximum and then fell. Manuring with ammonium sulphate seems to increase the pressures. The osmotic pressure of the root increases from the apex towards the base, and in the leaves from the base towards the apex. These relations between the osmotic pressure of the different regions are maintained during the whole active period.

The suction pressure of the plant was also determined during the whole season and a similar periodicity was observed as in the osmotic pressure. Manuring had a like effect. The suction pressure at the end of the season rose. This is an important point as it was found that at the end of the season the suction pressure was very nearly equal to the osmotic pressure.

A suggestion is made for making use of the changes in osmotic pressure produced after manuring with a salt to determine whether the salt is absorbed by the plant or not. [R. H. D. and E. B.]

**Milling and baking tests with some Indian wheats grown at Pusa and at Mirpurkhas (Sind).** F. J. F. SHAW. *Ind. J. of Agri. Science,* Vol. I, Pt. III, in the press.)

Wheats Pusa 4, 12, 52, 80-5, 111 and 114 were grown at Pusa and Mirpurkhas (Sind) and were sent to England for milling and baking tests. Samples of Sind wheats—C. P. H. 47, A. T. 38, G. S. 25—and a sample of Choice White Karachi were also sent. Wide variations in type and quality have been encountered amongst the sixteen samples—so much so, that the extremes almost might be said to typify "strength" and "weakness". On the whole the Pusa samples appeared of much higher quality than the Sind though it is perhaps not justifiable to make a clean-cut division. Certainly the finest samples were amongst the Pusa set, and of these Pusa 111 was outstanding. It appeared to be equivalent in value to a good Manitoba wheat, and we have no hesitation in saying that it should be of commercial importance as a strong wheat. It was most attractive in appearance although quite unlike Manitoba, its bright amber colour being in sharp contrast to the typical Manitoba red. It was of excellent milling quality. It appeared to offer no difficulties as regards conditioning treatment, and it seemed distinctly easier to mill than most customary hard wheats. It gave a high yield of flour which was of good appearance (of the hard wheat flour type), and had a remarkably low ash content and high protein content. Like many hard wheat flours it was not a good gasser. In the bakehouse it gave a dough of excellent handling qualities, with the wide fermentation tolerance of a strong flour, and excellent bread. It appeared to have the blending value of a strong flour. Pusa 80-5 was nearly as good generally as Pusa 111 Next in order of merit but a long way behind came Pusa 4.

A wheat of a weaker type may on account of certain qualities be of just as much commercial importance as a strong wheat In this connection certain of the Sind samples appear to deserve mention. As relatively weak wheats Pusa 12 and Pusa 114 appeared to have high blending value. They milled well as relatively soft wheats, and gave good white flours. Pusa 12 had a normal protein content for soft flours, but Pusa 114 had comparatively high protein content. It is true that they were not good gassers, and they had the restricted fermentation tolerance of weak flours, but they gave dough of good handling qualities, from the blending point of view, and they appeared to fine advantage in the bread. From all points of view these were superior to ordinary Karachi wheat as commercially used for blending in this country.

Many of the remaining samples may be said to fall between two stools in the sense that they possess neither the degree of strength of the best Pusa samples, nor the value of weakness for blending purposes of the best Sind samples.

The poorest samples are fairly definitely C. P. H. 47, A. T. 38 and Choice White Karachi, which are certainly of no more value than ordinary commercial Karachi wheat.

Any further attempt to rank the samples in order of merit must be tentatively made, and then in connection with the Sind samples alone. Pusa 111 and Pusa 12 are best left apart for reasons discussed.

The order of merit of the remaining Sind samples might be as follows :—

Pusa 80-5, Pusa 4, Pusa 111, G. S. 25, Pusa 52, Choice White Karachi, C. P. H. 47, and A. T. 38.

C. P. H. 47 and A. T. 38 are distinctly poorest; perhaps a fairly sharp dividing line might be drawn between Pusa 52 and Choice White Karachi. [F. J. F. S.]

## Coimbatore cane varieties in flooded areas of Florida. W. Newell. (*Florida Expt. Sta. Ann. Report*, 1929.)

The Coimbatore canes, especially Co. 281, were found to be remarkably indifferent to the flooded conditions attendant on the Miami hurricane. The conditions of water-logging to which this cane was subjected extended over a period of some three months. Following the subsidence of the water all buds upon physically sound cane were found to be hard and viable and the germination of under-ground buds was found to be normal. (*Facts about Sugar*, Vol. 25, No. 29, December 1930.)

## Notes on the Bionomics and Anatomy of *Corizoneura longirostris*, Hardwicke. S. K. Sen. *Ind. J. of Vet. Science and Animal Husbandry*, 1, 24).

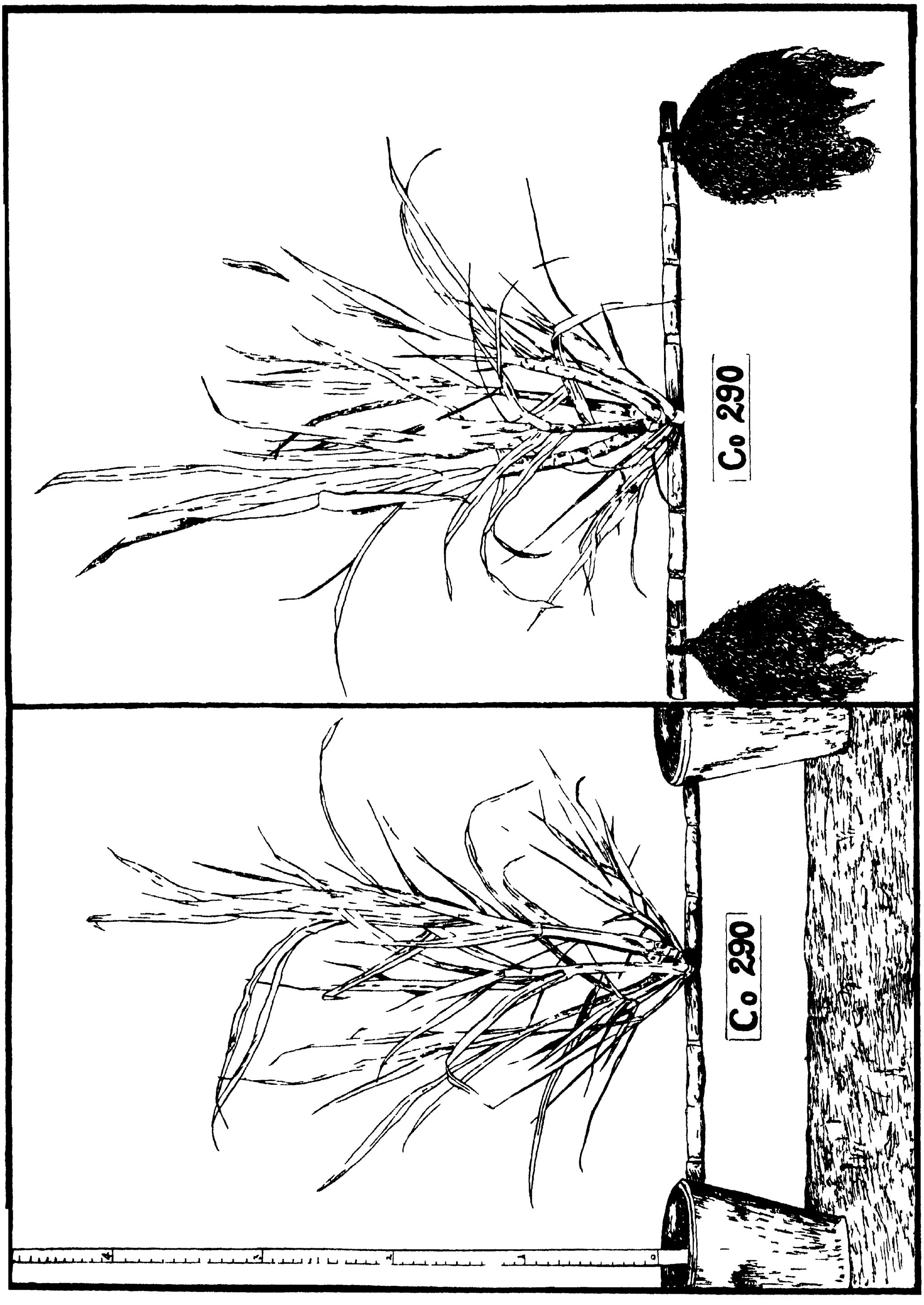
At Muktesar (Kumaon. 7,500 ft.) the seasonal prevalence of *Corizoneura longirostris* extends from the end of July to the beginning of September, and during this period they have been frequently observed to feed upon flowers of *Rescoea purpurea*, Smith (Family Scitamineae), these flowers making their appearance and disappearing about the same time as the flies themselves.

It appears that the mouth-parts of the female are adapted for sucking mammalian blood. In the course of the dissections large quantities of blood were detected in the alimentary tracts of at least two specimens, whilst in one instance a fly was actually observed to suck blood from a pony.

About 150 eggs, apparently in an advanced state of maturity, were dissected out in one instance. Attempts to induce the flies to oviposit in captivity were unsuccessful.

The reproductive tracts of both male and female *Corizoneura longirostris* are briefly described. [S. K. S.]

PLATE XXIV.




METHOD OF GROWING SUGARCANES FOR SPECIAL STUDIES

# NOTES

## METHOD OF GROWING SUGARCANES FOR SPECIAL STUDIES.

In the intensive study of sugarcanes at the Imperial Sugarcane Station, Coimbatore, various methods of growing the cane had to be devised to answer special requirements. Certain of these were designed to follow up the evolution and growth of the root system [Venkatraman and Thomas, 1924 ; Venkatraman and Thomas, 1929 ; Thomas, 1927].

Of these the growing of the plant from a vertically planted sett has proved useful in following up the shoot development as well, as in this method the process takes place at a convenient height above the soil. Yet another method with the same object in view has since been designed and is illustrated here (Plate XXIV).

The method consists in placing a cane piece with the two ends planted in soil in earthen pots one at each end. All the buds in the cane piece are carefully removed with the exception of the central one. By applying the proper amount of moisture to the earthen pots at either end, roots develop from the two end nodes ; and the central bud begins to grow and develop into an ordinary plant. It has been found possible to keep the plants growing almost normally for about four months. The whole cane piece remains healthy and sweet, apparently because of the active transmission of food material from either end to the growing plant in the centre. Other uses of the method would include the study of the changes in the juice of the cane at different stages of growth by periodically extracting the juice with a hypodermic syringe. The method is here published as other uses might suggest themselves to others engaged in sugarcane investigations. [R. Thomas and T. S. Venkatraman.]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## A HAND TALLY COUNTER.

Among the various labour-saving devices that are in use in the Agricultural Experiment Stations in the United States of America the Hand Tally Counter

seemed to be an extremely useful instrument to the writer. He has used it in counting healthy and dead plants in fields, in counting the leaves, flowers, pods, and bolls on plants, in counting sclerotia on potatoes affected by Rhizoctonia, in counting the spores of fungi under the microscope, in counting bacterial colonies in agar plates and in a variety of other ways. Its use to the plant breeder and geneticist, the plant pathologist and the bacteriologist, and the general agriculturist is thus very obvious.

The instrument has four figure wheels operated by pressure of the thumb lever. It can count up to 9, 999 and sets back to zero from any figure by one turn of the knob at right (Plate XXV, fig. 1). The counter can be held in either hand for use by slipping the finger ring on the proper finger. Plate XXV, figs. 2 and 3 further illustrate this instrument and the way of using it. In America it costs five dollars and it should not cost more than Rs. 15 in this country. [B. B. Mundkur.]

## VALUE OF GREEN BERSEEM FODDER.

*In replacing* guar *from a concentrate mixture in case of average Kankrej cows weighing 850 lbs. and yielding 10 lbs. of milk (from three teats, one being suckled to the calf) testing 3·5 p. c. fat under Chharodi conditions.*

According to the conditions obtainable at Chharodi, the milch cows (Kankrej breed) receive concentrates in a mixture which may consist of different ingredients in different parts, at different times of the year.

Berseem was grown for feeding it as green fodder to Chharodi farm cattle for the first time during the course of the agricultural season of the year 1929-1930, and it was desired to test the feeding value of green berseem fodder in replacing any one of the food stuffs in the concentrate mixture ; *guar* (*Cyamposis psoraloides*) was thus selected for being given a trial.

A scale of ration that would generally be given to an average Kankrej cow yielding 10 lbs. of milk (from three teats) are worked out as under.

| | |
|---|---|
| Wheat bran | 1½ lbs. |
| Til cake | 1½ ,, |
| Guar | 1 lb. |
| Tur phol | 1 ,, |
| | 5 lbs. |

PLATE XXV.

A HAND TALLY COUNTER.

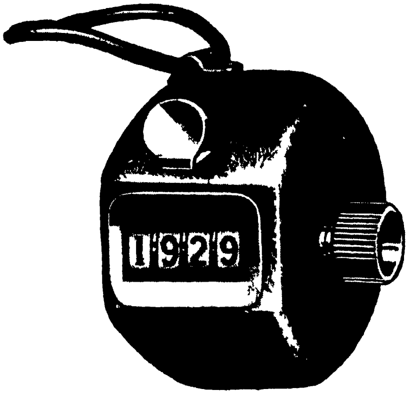


Fig 1

Fig 2

Fig. 3.

To the above ration one ounce of common salt was added and rock salt pieces were kept in the feed-trough of the animals at all the times.

The roughage requirements of animals were supplied from dry grazing in the pastures supplemented with hay served *ad libitum*, in the yards.

The above-shown mixture of concentrates together with hay would go to supply the following nutrients :—

| Names | Dry mattter in lbs. | Digestible crude protein | Total digestible nutrients | Nutrition ratio |
|---|---|---|---|---|
| Roughages— | | | | |
| Hay 18 lbs. . . . . . . | 16·20 | ·350 | 9·740 | .. |
| Concentrates— | | | | |
| Wheat bran 1½ lbs. . . . . . | 1·36 | ·175 | 931 | .. |
| Til cake 1½ lbs. . . . . . | 1·35 | ·567 | 1·231 | .. |
| Guar 1 lb. . . . . . | ·90 | ·220 | ·320 | .. |
| Tur phol 1 lb. . . . . . . | ·91 | ·032 | ·820 | .. |
| Total . | 20·72 | 1·344 | 13·04 2 | 8·7 |

According to modified Wooff and Lehmann standard, requirement of a cow weighing 850 lbs. yielding say 14 lbs. of milk (from the four teats) would work out as under :—

| —— | Dry matter in lbs. | Digestible crude protein in lbs. | Total digestible nutrients in lbs. | Nutrition ratio |
|---|---|---|---|---|
| Maintenance— | | | | |
| Requirements . . . . | 13·53 | 0·631 | 7·15 | 10·33 |
| For 14 lbs. of milk testing 3·5% fat . | 8·02 | 0·686 | 4·424 | 5·45 |
| Total . | 21·55 | 1·317 | 11·57 | 7·8 |

## EXPERIMENTAL WORK.

With a view, therefore, to see if 10 lbs. of green berseem fodder can be equal to one pound of *guar* in feeding results, an experiment was undertaken. Number and grouping of animals :—

Six cows were selected for the purpose of experiment and these were arranged into two groups of three each, as under :—

| Name with breed number and year of birth | Advancement in lactation | Average milk yield of 7 days before experiment, 17th to 23rd February 1930 | Average live weight for 6 days before experiment, 18th to 23rd February 1930 |
|---|---|---|---|
| | Months | Lbs. | Lbs. |
| GROUP A. | | | |
| Gomti 36—1923 . . . . | 6·5 | 9·53 | 939 |
| Patli 313—1916 . . . . | 4·25 | 7·28 | 826 |
| Ujol 298—1916 . . . . | 2·75 | 9·53 | 889 |
| Average . . . . . . | 4·5 | 8·78 | 884·66 |
| GROUP B. | | | |
| Vanzri 27—1923 . . . . | 6·25 | 9·57 | 852 |
| Ranebhi 38—1921 . . . . | 6 | 6·78 | 889 |
| Vanar 10—1920 . . . . | 2·75 | 11·21 | 883 |
| Average . . . . . . | 5·0 | 9·18 | 874·66 |

All the above six animals were brought to the uniform treatment as regards the feeds after their selection by giving them for a period of seven days uniform

ration at the rate of 5 lbs. (1½ lbs. wheat-bran, 1½ lbs. *til*-cake, 1 lb. *guar*, 1 lb. tur phol). Their milk production during this period as well as their live-weights were as under :—

| Names | Milk yield average of 7 days from 24th February 1930 to 2nd March 1930 | Live weight average of 7 days from 24th February 1930 to 2nd March 1930 |
|---|---|---|
| | Lbs. | Lbs. |
| GROUP A. | | |
| Gomti—1923 | 9·82 | 952 |
| Patli—1916 | 7·18 | 853 |
| Ujol—1916 | 10·07 | 895 |
| Average | 9·02 | 900 |
| GROUP B. | | |
| Vanzri—1923 | 9·28 | 854 |
| Ranebhi—1921 | 7·21 | 907 |
| Vanar—1920 | 11·03 | 878 |
| Average | 9·17 | 879 |

It will be seen from the above that the two groups were as uniform as could be had from the herd. All the 6 animals were carrying suckling calves, and it was arranged that the calf should be suckled from one teat alternately. The yield, therefore, recorded here is actually from three teats.

The experiment was conducted according to the two methods, firstly with the well-known reversion method and then with the method wherein all the 6 animals under experiment will go through the same treatment during a particular period. The latter method, instead of giving a trial once more to the reversion method, has to be adopted lest something going wrong with an animal or animals may go to vitiate the results.

In the statement that follows, the results under periods I and II are those obtained with the reversion method, and those under III, IV and V are from the "same treatment" method.

The statement gives in full all the details of the experiment as well as the results.

| I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|
| | | | | | Average | | |
| Treatment | Full guar (1 lb.) ration (no berseem) | ½ lb.+5 lbs. berseem | Full berseem ration (10 lbs.) (no guar) | No. of days | Live weight lbs. | Milk yield lbs. | Fat percentage in milk |
| Preliminary observation, 17th February 1930 to 23rd February 1930. | A+B | ... | ... | ... | 885<br>874 | 8·78<br>9·18 | ...<br>... |
| Standardizing period, 24th February 1930 to 2nd March 1930. | A+B | ... | ... | 7 | 900<br>879 | 9·02<br>9·17 | ...<br>... |
| I Change period, 3rd March 1930 to 4th March 1930. | B | A | .. | 2 | 899<br>874 | 9·37<br>9·67 | ...<br>... |
| I Experimental period, 5th March 1930 to 11th March 1930. | B | ... | A | 7 | 906<br>880 | 9·98<br>9·27 | 4·07<br>4·00 |
| Change period, 12th March 1930 to 13th March 1930. | ... | A+B | ... | 2 | 909<br>885 | 9·08<br>9·95 | ...<br>... |
| II Experimental period, 14th March 1930 to 20th March 1930. | A | ... | B | 7 | 905<br>887 | 9·06<br>10·15 | 3·43<br>3·83 |
| Change period, 21st March 1930 to 22nd March 1930. | ... | B+A | ... | 2 | 905<br>883 | 9·45<br>9·91 | ...<br>. |
| III Experimental period, 23rd March 1930 to 29th March 1930. | A+B | ... | ... | 7 | 910<br>888 | 9·19<br>9·99 | 3·5<br>3·68 |
| Change period, 30th March 1930 to 31st March 1930. | ... | A+B | ... | 2 | 915<br>892 | 8·99<br>10·24 | ...<br>... |
| IV Experimental period, 1st April 1930 to 7th April 1930. | ... | ... | A+B | 7 | 910<br>885 | 10·34<br>10·37 | 3·58<br>3·55 |
| Change period, 8th April 1930 to 9th April 1930. | ... | A+B | ... | 2 | 913<br>891 | 9·33<br>9·70 | ...<br>.. |
| V Experimental period, 10th April 1930 to 16th April 1930. | A+B | ... | ... | 7 | 908<br>894 | 9·69<br>9·66 | 3·36<br>3·35 |

NOTE.—Figures for 'A' group are shown first, and those for B group are shown below these in any column of this statement.

It would be better to have a consolidated statement of results obtained with the two different methods before one is in a position to say anything definite, and the following statement gives the results of the whole trial at a glance :—

*Consolidated Results of the Experiment.*

| Method of experiment | Group of animals | Berseem treatment | | | No berseem but guar treatment | | |
|---|---|---|---|---|---|---|---|
| | | Live weight lbs. | Milk yield lbs. | Fat per cent. in milk | Live weight lbs. | Milk yield lbs. | Fat per cent. in milk |
| Reversion method . . | A | 906 | 9·98 | 4·07 | 905 | 9·06 | 3·43 |
| | B | 887 | 10·15 | 3·83 | 880 | 9·27 | 4·00 |
| Total . | | 1,793 | 20·13 | 7·90 | 1,785 | 18·33 | 7·43 |
| Average . . . . . | | 896 | 10·06 | 3·59 | 892 | 9·16 | 3·71 |
| All same treatment method | A + B | 897 | 10·35 | 3·56 | 900 | 9·63 | 3·47 |
| Average of the two methods | | 896 | 10·25 | 3·75 | 896 | 9·39 | 3·59 |

The berseem ration provides the following nutrients :—

| Feeds | Dry matter lbs. | Digestible crude proteins lbs. | Total digestible nutrients lbs. | Nutrition Ratio |
|---|---|---|---|---|
| I. Roughages :— | | | | |
| Grass 15 lbs. (estimated) . . . . | 14·40 | 0·15 | 9·000 | .. |
| Green berseem fodder, 10 lbs. . . | 1·85 | 0·139 | 0·77 | .. |
| II. Concentrates :— | | | | |
| Wheat bran 1½ lbs. . . . . . | 1·36 | 0·175 | 0·931 | .. |
| Til cake 1½ lbs. . . . . . . | 1·35 | 0·567 | 1·231 | .. |
| Tur pol 1 lb. . . . . . . | 0·910 | 0·032 | 0·82 | .. |
| Total . | 19·87 | 1·063 | 12·752 | 11 |

NOTE.—In the case of berseem the following digestible coefficients are assumed from American figures :—

Crude protein . . . . . . . 44
Fat . . . . . . . . . 73
Carbohydrates . . . . . . . 65

The results would appear to be in favour of berseem treatment, which has given 0·86 lb. or 14 ozs. of more milk per head per day on an average from three teats; and an average increase of percentage of fat in milk by 0·16, the live-weight remaining the same under both the treatments.

The following are the figures of the nutritive ratio for the different treatments :—

(1) Nutritive ration actually required . . . . . . . 1:7·8

(2) Nutritive ration when concentrate mixture containing one pound of *guar* is used . . . . . . . . . . 1:8·7

(3) Nutritive ration when one pound of *guar* is replaced by 10 lbs. of green berseem fodder . . . . . . . . 1:11

It is evident from the above that though the nutritive ratio in case of berseem treatment is too wide, this has affected neither the quantity nor the quality of produce from the animal. On the contrary, both these points go in favour of berseem.

*Economic aspect.*

We have obtained an increase of 14 ozs. of milk per head per day on account of berseem feeding. This is from 3 teats of cow. If, therefore, yield from four teats is considered the increase would amount to something like one pound and 3 ozs.

One pound of *g ar* costs 11 pies, whereas 10 lbs. of green berseem fodder costs Re. 0-1-9 under Chharodi conditions, where about 63 per cent. of the total expenses after cultivation of the crop is to be borne on account of irrigation and after tillage charges, the latter consisting mostly of watching against the devastation of wild animals and birds. Therefore in the places where the crop could be cultivated and where facilities exist for bringing down the costs and where there are marketing facilities for milk, berseem fodder would no doubt prove to be a highly economic fodder.

Berseem fodder that was fed to the experimented animals was from the second and third cuttings of the crop, which are comparatively rich in nutrients, especially crude proteins. [Reprinted from the *Poona Agric. College Magazine*, Vol. XXII, No. 2, Sep. 1930.]

## THE INTERNATIONAL YEARBOOK OF AGRICULTURAL STATISTICS.

The International Institute of Agriculture at Rome has recently published the 1929-30 edition of the International Yearbook of Agricultural Statistics.

This volume of about 800 pages is the result of the most extensive and detailed inquiry made in the domain of international agricultural statistics and constitutes

a work of the greatest importance to all those who are interested in questions having a direct or indirect relation to production and commerce of agricultural products.

In the first part of the Yearbook are classified the figures for area and population in the years nearest to 1913 and 1929 for 220 countries: the presentation of these figures throws light upon the world situation from the geographical, political and demographical points of view during both the pre-war and post-war periods. The second part is composed of a series of tables comprising for nearly 50 countries the available data concerning the uses for which the total area is employed, the apportionment of cultivated areas between the different crops, agricultural production, numbers of the different kinds of live-stock and the products derived from them. In the tables constituting the third part of the volume, have been indicated for nearly 40 agricultural products, the area, production and yield per acre in each country during the last five years of the pre-war period and during each of the years from 1926 to 1929.

For each kind of live-stock, all available figures in the different countries have been grouped for the years 1913 and 1925 to 1929. A large part of the volume is devoted to statistics of the commercial movement of 42 vegetable products and 12 products of animal origin. The figures published relate to the imports and exports during the calendar years and for the cereals also during the commercial seasons.

It may be added that the tables of production and commerce not only specify details for each country but also the totals for the different continents and hemispheres and for the whole world, allowing the formation of a general idea of the changes taking place during the periods under consideration in the area under each crop, quantities harvested and the commercial movement in each product.

The part devoted to prices contains the weekly quotations of 25 agricultural products on the principal world markets for the year 1913 and for the period January 1926 to June 1930. In the freights section will be found the quotations for the carriage of wheat, maize and rice on the most important shipping routes, and in the section reserved for fertilizers and chemical products useful in agriculture are published statistics of production, trade and prices for 15 products. In the rates of exchange section are set out the rates on the New York exchange for the most important currencies.

For the first time there have been introduced into the volume special chapters on the importance and distribution of the agricultural population, the distribution of the agricultural holdings according to their size and mode of tenure and forestry.

The volume has also been enriched by a long introduction and a chapter of explanatory notes.

# Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

On return from deputation in Europe, Dewan Bahadur Sir T. Vijayaraghavacharya, K.B.E., resumed charge of the office of the Vice-Chairman of the Imperial Council of Agricultural Research on the forenoon of the 27th December, 1930.

Mr. B. C. Burt, B.Sc., C.I.E., M.B.E., I.A.S., Agricultural Expert, Imperial Council of Agricultural Research, has been granted leave on average pay for 7 months and 4 days with effect from the forenoon of the 20th March, 1931.

Mr. F. J. Plymen, C.I.E., I.A.S., Director of Agriculture, Central Provinces, has been nominated by the Government of the Central Provinces to be a member of the Indian Central Cotton Committee, Bombay, *vice* Mr. R. G. Allan resigned.

Mr. W. Sayer, B.A., I.A.S., Secretary, Sugar Bureau, and Officiating Imperial Agriculturist, Imperial Institute of Agricultural Research, Pusa, has been granted leave on average pay for 8 months with effect from the 1st March, 1931, or subsequent date from which he may avail himself of it.

*Madras.*

Mr. G. A. Ajwani, M.Sc., D.V.M., D.V.H., G.B.V.C., acting Lecturer in Pathology and Bacteriology, Madras Veterinary College, has been appointed to be a member of the Madras Veterinary Service with effect from the 10th December, 1930.

*Bengal.*

Mr. F. Smith, B. Sc. (Edin.), F.H.A.S., M.R.A.S.E., I.A.S., Deputy Director of Agriculture, Eastern Circle, Bengal, has been granted leave for the period from the 6th March to the 30th November, 1931.

*Bengal.*

Khan Sahib SAIYID SULTAN AHMED, G.B.V.C., Lecturer, Bengal Veterinary College, has been appointed to act as Vice-Principal, Bengal Veterinary College, in the Bengal Higher Veterinary Service, with effect from the 1st May 1930.

*United Provinces.*

Mr. T. S. DAVIES, Deputy Superintendent, Civil Veterinary Department, United Provinces, has been allowed to continue to be in charge of the duties of the post of Superintendent, Civil Veterinary Department, United Provinces, *vice* Major W. H. Priston granted leave out of India preparatory to retirement.

Dr. A. E. PARR, B.Sc., Ph.D., I.A.S., Deputy Director of Agriculture, United Provinces, has been granted in continuation of the extension of leave already notified, a further extension of leave on half average pay from the 26th November, 1930 to the 11th August, 1931, preparatory to retirement.

Rai Bahadur L. C. SHARMA, F.S.I., M.R.A.C., Bar.-at-Law, I.A.S., Deputy Director of Agriculture, United Provinces, has been confirmed in the Selection Grade of the Indian Agricultural Service with effect from the 30th July, 1930.

Mr. S. C. ROY, M.Sc. (Alld.), B.Sc. (London), has been appointed Assistant Deputy Director of Agriculture, United Provinces, on probation for two years, with effect from the 29th September, 1930, but will continue as temporary Professor of Botany at the Agricultural College, Cawnpore.

M. MOHI-UD-DIN AHMAD, Temporary Deputy Director of Agriculture, United Provinces, has been transferred from the Western Circle, Aligarh, to the North-Eastern Circle, Gorakhpur, in the same capacity.

Khan Sahib MAULVI ABDUL QAYUM, Temporary Deputy Director of Agriculture, United Provinces, has been transferred from the North Eastern Circle, Gorakhpur, to the Western Circle, Aligarh, in the same capacity.

*Burma.*

Mr. J. SMITH, M.R.C.V.S., has been appointed to the Burma Veterinary Service, Class I, and posted as Veterinary Research Officer with headquarters at Rangoon.

Mr. R. WATSON, N.D.A., I.A.S., Deputy Director of Agriculture, Burma, has been granted leave for nine months with effect from the 20th January, 1931, or the date on which he may avail himself of it.

U. SAW TUN, B.Ag., Assistant Director of Agriculture, Myingyan Circle, has been appointed to officiate as Deputy Director of Agriculture, Myingyan Circle, in addition to his own duties in place of Mr. R. Watson proceeding on leave.

*Bihar and Orissa.*

Mr. P. G. MALKANI, B.Sc., M.R.C.V.S., has been appointed Research Officer and Professor of Pathology and Bacteriology at the Bihar and Orissa Veterinary College, with effect from the 30th September, 1930.

The term of appointment of Mr. MOHAMMAD ISMAIL MALIK, B.Sc., M.R.C.V.S., Special Officer in the Civil Veterinary Department, Bihar and Orissa, has been further extended for three years with effect from the 1st December, 1930.

Mr. DAULAT RAM SETHI, M.A., B.Sc. (Edin.), I.A.S., Deputy Director of Agriculture, South Bihar Range, has been granted leave for nine months with effect from the 3rd March, 1931.

Babu BHUT NATH SARKAR, L.Ag., Assistant Director of Agriculture, has been appointed to hold charge of the South Bihar Range during the absence on leave of Mr. Daulat Ram Sethi.

*Central Provinces.*

Mr. S. T. D. WALLACE, B.Sc. (Edin.), I.A.S., Deputy Director of Agriculture in charge of Animal Husbandry, Central Provinces, has been granted leave for ten months with effect from the 3rd January, 1931.

Rai Bahadur TUNDILAL POWAR, B.A., Deputy Director of Agriculture, Eastern Circle, Raipur, has been granted leave for four months with effect from the 15th February, 1931, or the subsequent date on which he takes it.

Mr. J. V. TAKLE, L.Ag., N.D.D., Extra Assistant Director of Agriculture, has been appointed to officiate as Deputy Director of Agriculture in charge of Animal Husbandry, Central Provinces, *vice* Mr. S. T. D. Wallace, proceeding on leave.

On return from leave, Mr. D. R. MOHRIKAR, Extra Assistant Director of Agriculture, Central Provinces, has been appointed to officiate as Deputy Director of Agriculture in the Central Provinces Agriculture Service, Class I, and posted to the Eastern Circle, Raipur, *vice* Rai Bahadur Tundilal Powar, proceeding on leave.

Rai Sahib R. V. PILLAI, G.B.V.C., Deputy Director of Veterinary Services, Central Provinces, has been granted leave on average pay for eight months with effect from the 16th January, 1931, or the subsequent date on which he takes it.

# NEW BOOKS

## On Agriculture and Allied Subjects

Note-book of Agricultural Facts and Figures for Farmers and Farm Students. By Primrose McConnel. Eleventh Edition. Pp. 540. (London : Crosby Lockwood & Son, 1930.) 15*s*. net.

Fruit Production—Tree Fruits. Bulletin No. 2 of the Ministry of Agriculture and Fisheries. Pp. v+110+23 plates. (London : Ministry of Agriculture and Fisheries.) 1*s*. 6*d*. net.

Fruit Production—Soft Fruits and Nuts. Bulletin No. 4 of the Ministry of Agriculture and Fisheries, Pp. v+69+20 plates. 1*s*. net. (London : Ministry of Agriculture and Fisheries, 1930).

The Cactus Book. By Arthur D. Houghton. Pp. xii+147+12 plates. (New York : The Macmillan Co., 1930.) 10*s*. net.

Agricultural Accounts. By T. Wheeler Meats. Third Edition. Revised by L. F. Foster. Pp. 68. (London : Gee & Co., Ltd., 1930.) 6*s*. net.

A Text-book of Plant Physiology. By N. A. Maximov. Translated from the Russian. Edited by A. E. Murneek and R. B. Harvey. (McGraw-Hill publications in the Agricultural and Botanical Sciences.) Pp. xiii+519. (New York : McGraw-Hill Book Co., Inc.; London : McGraw-Hill Publishing Co., Ltd., 1930.) 20*d*. net.

Elements of Plant Science. By C. J. Chamberlain. Pp. xii+394. (New York : McGraw-Hill Book Co., Ltd., 1930.) 9*s*. 6*d*. net.

A Manual of the Dragonflies of China—a Monographic Study of the Chinese Odonata. By James G. Needham. (Zoologia Sinica, Series A : Invertebrates of China, Vol. I, Fascicle I.) Pp. ii+344+11+20 plates. (Peiping : The Fan Memorial Institute of Biology, 1930.) 5 dollars ; 20*s*.

Laboratory Studies in Zoology. By H. D. Reed and B. P. Young. Pp. 121. (New York : McGraw-Hill Book Co., Inc. ; London McGraw-Hill Publishing Co., Ltd., 1930.) 5*s*. net.

Recent Advances in Entomology. By A. D. Imms. The Recent Advances Series. Pp. viii+374. (London : J. and A. Churchill, 1931.) 12*s*. 6*d*.

Judging Poultry for Production. By J. E. Rice, G. O. Hall and D. R. Marble. (Poultry Science Series.) Pp. xii+425. (New York : John Wiley & Sons, Inc. ; London : Chapman & Hall, Ltd., 1930.) 18*s*. 6*d*. net.

Production, Condition, Organization and Results of Czechoslovak Farming. Edited by Vladislao Brdlik. Part II. Pp. 242+79. (Prague : State Agricultural Institute, 1930.) 24*s*.

# List of Agricultural Publications in India from 1st August 1930 to 31st January 1931.

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE** | | |
| 1 | *The Agricultural Journal of India*, Vol XXV, Parts V and VI. Price, Rs. 1-8-0 or 2s. per part. Annual subscription, Rs. 6 or 9*s*. 6*d*. | Issued under the authority of the Imperial Council of Agricultural Research. | Government of India Central Publication Branch, Calcutta. |
| 2 | *Agriculture and Live-stock in India*, Vol. I, Part I. Price, Rs. 1-8-0 or 2*s*. 6*d*. per part. Annual subscription, Rs. 6 or 9*s*. 9*d*. | Ditto . . | Ditto. |
| 3 | *The Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Rs. 3. | E Narasinha Ayenger (Editor). | Bangalore Press, Bangalore. |
| 4 | *The Madras Agricultural Journal* (Monthly). Annual subscription, Rs. 4. | B. Viswanath and others (Editors). | The Electric Printing Works, Coimbatore. |
| 5 | *Poona Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 2-8-0. | V. G. Deshpande and S. M. Rao (Editors). | Aryabhushan Press, Poona City. |
| 6 | *The Nagpur Agricultural College Maga-ine* (Quarterly). Annual subscription, Rs. 3. | S. M. Ali and N. B. Chinchalkar (Editors). | Udyam Desha Sevak Press, Nagpur. |
| 7 | *The Allahabad Farmer* (Quarterly). Annual subscription, Rs. 2. | W. B. Hayes (Editor) . | The Mission Press, Allahabad. |
| 8 | *Quarterly Journal of the Indian Tea Association*. Price, As. 6 per copy | Scientific Department of the Indian Tea Association, Calcutta. | Catholic Orphan Press, Calcutta. |
| 9 | *The Planters' Chronicle* (Weekly). Price, As. 8 per copy. | F. E. James (Editor) . | Diocesan Press, Post Box 455, Madras. |
| 10 | *Rural India* (Monthly). Annual subscription, Rs. 3. | A. Swaminatha Iyer (Editor). | Magazine Press, Chingleput, South India. |
| 11 | *Journal of the Trichinopoly District Agricultural Association* (Quarterly). Annual subscription, Rs. 1-8-0 for non-members; free for members. | Issued by the Trichinopoly District Agricultural Association. | District Agricultural Association, Trichinopoly South India. |

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE**—*contd.* | | |
| 12 | Digest of the Operations of the Department of Agriculture, Madras, for quarter ending 31st March 1930. (Tamil, Telugu and Malayalam). Madras Department of Agriculture Digest No. 87. | D. Ananda Bow . . | Government Press, Madras. |
| 13 | Digest of the Operations of the Department of Agriculture ,Madras, for quarter ending 30th June 1930. (English, Tamil, Telugu and Malayalam). Madras Department of Agriculture Digest No. 88. | Ditto . . | Ditto. |
| 14 | Digest of the Operations of the Department of Agriculture, Madras, for quarter ending 30th September 1930. (English, Tamil, Telugu, Malayalam and Kanarese). Madras Department of Agriculture Digest No. 89. | Ditto . . | Ditto. |
| 15 | Villagers' Calendar for 1930-31 (Malayalam). | Issued by the Department of Agriculture, Madras. | Ditto. |
| 16 | Villagers' Calendar for 1931. (English) | Ditto . . | Ditto. |
| 17 | Potatoes. (English, Telugu, Tamil, Malayalam and Kanarese). Madras Department of Agriculture Leaflet No. 65. | F. H. Butcher . . | Ditto. |
| 18 | Note on Turmeric. (English, Telugu, Tamil, Malayalam and Kanarese). Madras Department of Agriculture Leaflet No. 67. | Issued by the Department of Agriculture, Madras. | Ditto. |
| 19 | School Garden. (English, Tamil, Telugu, Kanarese and Malayalam). Madras Department of Agriculture Leaflet No. 68. | Ditto . . | Ditto. |
| 20 | Water rate or Fasalijasti for certain crops-concession made by Government to ryots in aid of cultivation. (English, Telugu, Tamil, Kanarese and Malayalam). Madras Department of Agriculture Leaflet No. 69. | Ditto . . | Ditto. |
| 21 | How to send specimens. (English, Tamil, Telugu and Malayalam). Madras Department of Agriculture Leaflet No. 71 and 71 (*a.*) | S. R. Srinivasa Iyenger . | Ditto. |

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE**—*contd.* | | |
| 22 | Planting of Trees. Standing Order of the Board of Revenue, Land Revenue and Settlement. (English, Malayalam, Telugu and Tamil). Madras Department of Agriculture Leaflet No. 73. | Issued by the Department of Agriculture, Madras. | Government Press, Madras |
| 23 | Loans to ryots. (English, Telugu, Tamil, Kanarese and Malayalam). Madras Department of Agriculture Leaflet No. 74. | Ditto . . | Ditto. |
| 24 | Broad Hints for every day use, No. 1. (English, Telugu, Tamil, Malayalam and Kanarese). | G. R. Hilson . . . | Ditto. |
| 25 | Note on Pure Paddy Seed, VIII Circle. (English and Tamil). | R. C. Broadfoot . . | Ditto. |
| 26 | Artificial Fertilizers. Bengal Department of Agriculture Leaflet No. 4 of 1929. | Issued by the Department of Agriculture, Bengal. | Bengal Secretariat Book Depôt, Calcutta. |
| 27 | Cultivation of English Vegetables. Bengal Department of Agriculture Leaflet No. 5 of 1929. | Ditto . . | Ditto. |
| 28 | Tobacco in Bengal. Bengal Department of Agriculture Bulletin No. 6 of 1929. | Ditto . . | Ditto. |
| 29 | Improved Ploughs for the use of the Bengal Cultivators. | Ditto . . | Ditto. |
| 30 | Notes on Crops which can be substituted for Jute. (English and Bengali). Bengal Department of Agriculture Leaflet No. 7 of 1930. | Ditto . . | Ditto. |
| 31 | Notes on why Fodder Crops should be substituted for Jute and Paddy. (English and Bengali). Bengal Department of Agriculture Leaflet No. 1 of 1931. | Ditto . | Ditto. |
| 32 | Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending June 30, 1930. | Issued by the Department of Agriculture, United Provinces. | Superintendent, Government Press, United Provinces, Allahabad. |
| 33 | Report on the Agricultural Stations of the Central Circle, Cawnpore, United Provinces, for the year ending June 30, 1930. | Ditto . . | Ditto. |

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE**—*contd.* | | |
| 34 | Report on the Agricultural Stations of the Western Circle, Aligarh, United Provinces, for the year ending June 30, 1930. | Issued by the Department of Agriculture, United Provinces. | Superintendent, Government Press, United Provinces, Allahabad. |
| 35 | Combined Report on the Experimental Stations in the Eastern Circle, Partabgarh, United Provinces, for the year ending May 31, 1930. | Ditto . | Ditto. |
| 36 | Report on the Agricultural Stations in the Rohilkhand Circle, Shahjahanpur, United Provinces, for the year ending June 30, 1930. | Ditto . . | Ditto. |
| 37 | Report on the Agricultural Stations of the North Eastern Circle, Gorakhpur, United Provinces, for the year ending June 30, 1930. | Ditto . . | Ditto. |
| 38 | Report on the Agricultural Stations in the Bundelkhand Circle, Jhansi, United Provinces, for the year ending June 30, 1930. | Ditto . . | Ditto. |
| 39 | Report on the Agricultural Stations in the Hill Circle, Jeolikote, United Provinces, for the year ending June 30, 1930. | Ditto . . | Ditto. |
| 40 | Reports on the working and Administration of the United Provinces Gardens for the year 1929-30. | Ditto . . | Ditto. |
| 41 | Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1929. Part II, Vol. I. Price, Rs. 6. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 42 | Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1929. Part II, Vol. II. Price, Rs. 20. | Ditto . . | Ditto. |
| 43 | Information regarding Boring of Wells by the Agricultural Department, Punjab. Punjab Department of Agriculture Leaflet No. 84. | Ditto . . | Ditto. |
| 44 | Hints on Cotton Cultivation, Punjab Department of Agriculture Leaflet No. 86. | Ditto . . | Ditto. |

## GENERAL AGRICULTURE—*contd.*

| No. | Title | Author | Where published |
|---|---|---|---|
| 45 | Guide to the Punjab Agricultural College and Research Institute, Lyallpur. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 46 | Enquiries regarding Indian Oilseed Crops. Price, As. 9. | K. S. Ch. Ali Mohammad, B.Sc. (Agri.) L. Ag. | Ditto. |
| 47 | Prospectus of the Punjab Agricultural College, Lyallpur. Price, As. 4. | Issued by the Department of Agriculture, Punjab. | Ditto |
| 48 | Seasonal Notes for October 1930. Price, As. 4. | Ditto . . | Ditto. |
| 49 | Annual Report of the Department of Agriculture, Bihar and Orissa, 1929-30. | Issued by the Department of Agriculture, Bihar and Orissa. | Government Printing, Bihar and Orissa, Gulzarbagh. |
| 50 | Annual Report on Experimental Stations in Bihar and Orissa, 1928-29. | Ditto . . | Ditto. |
| 51 | Annual Report on Experimental Stations in Bihar and Orissa, 1929-30. | Ditto . . | Ditto. |
| 52 | Bunds in Chota Nagpur Range. (English, Bengali and Hindi). Bihar and Orissa Department of Agriculture Bulletin No. 1 of 1930. | Ditto . . | Ditto. |
| 53 | Sugarcane in Chota Nagpur. (English, Bengali, Oriya and Hindi) Bihar and Orissa Department of Agriculture Bulletin No. 2 of 1930. | Ditto . . | Ditte. |
| 54 | Summary of Improvements in Agriculture recommended by the Department of Agriculture, Bihar and Orissa. Bihar and Orissa Department of Agriculture Bulletin No. 3 of 1930. | Ditto . . | Ditto. |
| 55 | Leaflet on Sugarcane in South-East Bihar Range. Leaflet No. 1 of 1930. | Ditto . . | Ditto. |
| 56 | Report on the working of the Department of Agriculture of the Central Provinces for the year ending 31st March 1930. | Issued by the Department of Agriculture, Central Provinces. | Government Printing, Central Provinces, Nagpur. |

| No. | Title | Author | Where published |
|---|---|---|---|
| | **GENERAL AGRICULTURE—*contd*** | | |
| 57 | Report on Demonstration work carried out in Southern Circle together with reports on the Seed and Demonstration Farms, Waraseoni and Sindewahi and the Cattle Breeding Farm, Sindewahi, Central Provinces, for the year ending 31st March 1929. Price, Re. 1. | Issued by the Department of Agriculture, Central Provinces. | Government Printing. Central Provinces, Nagpur. |
| 58 | Annual Reports of Experimental Farms of the Southern and Eastern Circles, Tharsa and Raipur, Central Provinces, for the year ending 31st March 1929. Price, Re. 1. | Ditto . . | Ditto. |
| 59 | Report on Demonstration work carried out in the Western Circle together with reports on the Seed and Demonstration and Cattle Breeding Farms of that Circle for the year ending 31st March 1929. (Vols. I and II). Price, Re. 1 each volume. | Ditto . . | Ditto. |
| 60 | Report on Demonstration work carried out in the Eastern Circle together with reports on the Seed and Demonstration Farms at Chandkhuri, Bilaspur and Drug with that of Cattle Breeding Station attached thereto for the year ending 31st March 1929. Price, Re. 1. | Ditto . . | Ditto. |
| 61 | Report on the (1) Agricultural College, Nagpur, (2) Chemical, Botanical, Mycological and Entomological Research, (3) Agricultural Engineer's Section, (4) Maharajbagh Menagerie together with the external work of the Veterinary Inspector attached to the Agricultural College, Nagpur, for the year ending 31st March, 1929. Price, Re. 1. | Ditto . . | Ditto. |
| 62 | The Cultivation of Ground-nut. (Marathi). Bulletin No. 22 of the Department of Agriculture, Central Provinces. Price, As. 2. | Ditto . . | Ditto. |
| 63 | A Leaflet on Instructions about Rogueing alien Plants from Verum (Marathi). | Ditto . . | Ditto. |

## GENERAL AGRICULTURE—*concld.*

| No. | Title | Author | Where published |
|---|---|---|---|
| 64 | Annual Report of the Department of Agriculture, Assam, for 1929-30. | Issued by the Department of Agriculture, Assam. | Government Press, Shillong. |
| 65 | Yellowing of Rice Seedlings. (Assamese and Bengali). Assam Department of Agriculture. Leaflet No. 2 of 1930. | Ditto . . | Ditto. |

## AGRICULTURAL STATISTICS.

| No. | Title | Author | Where published |
|---|---|---|---|
| 66 | Agricultural Statistics of Bihar and Orissa for 1929-30. | Issued by the Department of Agriculture, Bihar and Orissa. | Government Printing, Bihar and Orissa, Gulzarbagh. |
| 67 | Season and Crop Report of Bihar and Orissa for 1929-30. | Ditto . . | Ditto. |
| 68 | Season and Crop Report of the Punjab for the year ending 30th June 1930. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |

## FRUIT CULTURE.

| No. | Title | Author | Where published |
|---|---|---|---|
| 69 | Papaya cultivation in the Bombay Presidency (excluding Sind). Bombay Department of Agriculture Bulletin No. 162 of 1930. Price, As. 3. | Dr. G. S. Cheema and P. G. Dani. | Government Central Press, Bombay. |
| 70 ✓ | How to place oranges in the market. Punjab Department of Agriculture Leaflet No. 79. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 71 | On Protection of Fruit Trees from Frost. Punjab Department of Agriculture Leaflet No. 81. | Ditto . . | Ditto. |

## SERICULTURE.

| No. | Title | Author | Where published |
|---|---|---|---|
| 72 | Silk Industry in Bengal. Department of Agriculture Leaflet No. 6 of 1930. | Issued by the Department of Agriculture, Bengal. | Bengal Secretariat Book Depôt, Calcutta. |

| No. | Title | Author | Where published |
|---|---|---|---|
| | **AGRICULTURAL CHEMISTRY.** | | |
| 73 | Studies in Soil Colloids. Part I—Base exchange and soil acidity; Part II—Factors influencing the dispersion of soil colloids in water. Memoirs of the Department of Agriculture in India, Chemical Series, Vol XI, Nos. 1 and 2. Price, Re. 1 or 1*s*. 9*d*. | Amar Nath Puri, M. Sc., Ph.D., A.I.C. | Government of India Central Publication Branch, Calcutta. |
| 74 | The Nutritive value of some Typical Indian Hays. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. XI, No. 4. Price, As. 5 or 6*d*. | F. J. Warth, M.Sc . . | Ditto. |
| 75 | The Nutritive value of Gram Husk Memoirs of the Department of Agriculture in India, Chemical Series, Volume XI, No. 5. Price, As. 6 or 8*d*. | F. J. Warth, M.Sc., and Lal Chand Sikka, B.Sc. (Agri.) | Ditto. |
| 76 | Studies in Soil Colloids, Part III—Flocculation of soil colloids. Memoirs of the Department of Agriculture in India, Chemical Series, Volume XI, No. 6. | Amar Nath Puri, M. Sc., Ph.D., A.I.C. | Ditto. |
| 77 | Studies in Soil Colloids, Part IV—Methods of estimating soil colloids. Memoirs of the Department of Agriculture in India, Chemical Series, Volume XI, No. 7. Price, As. 5 or 6*d*. | Ditto . . | Ditto. |
| 78 | Studies in Soil Colloids, Part V—Methods of determining saturation capacity and degree of saturation of soils. Memoirs of the Department of Agriculture in India, Chemical Series, Volume XI, No. 8. Price, As. 3 or 4*d*. | Ditto . . | Ditto. |
| | **BOTANY.** | | |
| 79 | Cotton Growing in India in relation to climate. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVII, No. 5. Price, As. 12 or 1*s*. 3*d*. | Trevor Trought, M. A., and Mohammad Afzal, B.Sc. (Agri.), A.I.C.T.A. | Government of India Central Publication Branch, Calcutta. |

| No. | Title | Author | Where published |
|---|---|---|---|
| | **BOTANY**—*contd.* | | |
| 80 | Classification and Study of the Characters of the Cultivated Rice in the United Provinces. Memoirs of the Department of Agriculture in India, Botanical Series, Volume XVIII, No. 6. Price, Re. 1-10 or 2*s*. 6*d*. | R. L. Sethi, M.Sc., B.Sc., M.R.A.S., and Baijanti Prasad Saxena, L.Ag. | Government of India Central Publication Branch, Calcutta. |
| 81 | The Inheritance of Characters in Rice, Part III. Memoirs of the Department of Agriculture in India, Botanical Series. Volume XVIII, No. 7 Price, As. 14 or 1*s*. 6*d*. | K. Ramiah, L.Ag. (Madras), M.Sc., Dip. Agric. (Cantab.) | Ditto. |
| 82 | The Grain Shedding Character in Rice Plants and its Importance. Pusa Bulletin No. 205. Price, As. 12 or 1*s*. 3*d*. | S. G. Bhalerao, B.Ag. . | Ditto. |
| | **MYCOLOGY.** | | |
| 83 | Root-rot of Paddy. Bengal Department of Agriculture Leaflet No. 8 of 1930. (English and Bengali). | Issued by the Department of Agriculture, Bengal. | Bengal Secretariat Book Depôt, Calcutta |
| 84 | Betelvine disease. Bengal Department of Agriculture Leaflet No. 5 of 1930. (English and Bengali). | Ditto . . | Ditto. |
| 85 | The Early Blight of Potatoes and its Control. Punjab Department of Agriculture Leaflet No. 83. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 86 | Grain Smut of Jowar and its Prevention. Punjab Department of Agriculture Leaflet No. 85. | Ditto . . | Ditto. |
| | **BACTERIOLOGY.** | | |
| 87 | The influence of Exchangeable Ions in Soil Colloids on Bacterial Activity and Plant Growth. Memoirs of the Department of Agriculture in India, Bacteriological Series, Volume II, No. 4. Price, As. 7 or 9*d*. | N. V. Joshi, B.A., M.Sc., L.Ag., and A. N. Puri, M.Sc., Ph.D., A.I.C. | Government of India Central Publication Branch, Calcutta. |
| | **ENTOMOLOGY.** | | |
| 88 | Carabidæ. Catalogue of Indian Insects, Part 18. Price, Rs. 8-10 or 14*s*. 6*d*. | H. E. Andrewes. . . | Government of India Central Publication Branch, Calcutta. |

| No. | Title | Author | Where published |
|---|---|---|---|
| | **ENTOMOLOGY**—*contd.* | | |
| 89 | Gyrinoidea. Catalogue of Indian Insects, Part 19. Price, As. 12 or 1*s.* 3*d.* | Georg Ochs. | Government of India Central Publication Branch, Calcutta. |
| 90 | How to Control the Jasmine Bug (English, Tamil, Telugu and Kanarese). Madras Department of Agriculture Leaflet No. 66. | Y. Ramachandra Rao | Government Press, Madras. |
| 91 | Insect and General Control of Insect pest. Bengal Department of Agriculture Bulletin No. 3 of 1929. | Issued by the Department of Agriculture, Bengal. | Bengal Secretariat Book Depôt, Calcutta. |
| 92 | On Maize and Jowar Borers and their control. Punjab Department of Agriculture Leaflet No. 82. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 93 | Pamphlet on "Methods for the control of locusts" published by the Imperial Council of Agricultural Research (in Gurmukhi). | Ditto | Ditto. |
| 94 | A Leaflet on Common Insecticides and their uses. | Issued by the Department of Agriculture, Central Provinces. | Central Provinces Government Printing, Nagpur. |
| | **ANIMAL HUSBANDRY AND DAIRYING.** | | |
| 95 | *The Journal of the Central Bureau for Animal Husbandry and Dairying in India*, Volume IV, Parts III and IV. Price, As. 10 per part. Annual subscription, Rs. 2-8-0. | Issued under the authority of the Imperial Council of Agricultural Research. | Government of India Central Publication Branch, Calcutta. |
| 96 | Breeding and Rearing of Cattle and Buffaloes (Revised). (Tamil, Telugu, Malayalam and Kanarese). Madras Department of Agriculture Leaflet No. 31. | R. W. Littlewood | Government Press, Madras. |
| 97 | Note on Ensilage (Revised). (Tamil, Telugu, Malayalam and Kanarese). Madras Department of Agriculture Leaflet No. 43. | Ditto | Ditto. |
| 98 | Conditions to be fulfilled for the grant of Government premia for Breeding Bulls maintained by private bodies (Revised). | Ditto | Ditto. |

| No. | Title | Author | Where published |
|---|---|---|---|
| | **ANIMAL HUSBANDRY AND DAIRYING**—*contd.* | | |
| 99 | Rations of Milch cows, Dry cows and Calves. Reprint. (English, Tamil, Kanarese, Telugu and Malayalam). Madras Department of Agriculture Leaflet No. 60. | R. W. Littlewood . . | Government Press, Madras. |
| 100 | Broad Hints for everyday use. No. III. Feed your cow. (English, Tamil, Telugu, Malayalam and Kanarese). Madras Department of Agriculture Leaflet No. 70. | Ditto . . | Ditto. |
| 101 | The Table Poultry Industry. Punjab Department of Agriculture Leaflet No. 87. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 102 | Suggested Rations for Municipal Bullocks, etc., in Bihar and Orissa. Bihar and Orissa Department of Agriculture Leaflet No. 2 of 1930. | Issued by the Department of Agriculture, Bihar and Orissa | Government Printing, Bihar and Orissa, Gulzarbagh. |
| 103 | Report on the Cattle Breeding Operations in the Central Provinces and Berar for the year ending 31st March 1929. Price Re. 1. | Issued by the Department of Agriculture, Central Provinces. | Central Provinces Government Printing, Nagpur. |
| | **VETERINARY.** | | |
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| 105 | Annual Report, Civil Veterinary Department, Punjab, for the year 1929-30. | Issued by the Director, Veterinary Services, Punjab. | Government Printing, Punjab, Lahore. |
| 106 | List of Horses and Cattle Fairs and Shows in the Punjab and Punjab States during the year 1930-31. | Ditto . | Ditto. |
| 107 | Interim Report on the Immunization of Draft Animals in Burma against Anthrax. | Issued by the Director, Veterinary Services, Burma. | Government Press, Rangoon. |

MGIPC—S1—III-1-151—16-5-31—2,000.

PLATE XXVI.

RUDOLPH D. ANSTEAD, ESQR., C.I.E., M.A., I.A.S.

# RUDOLPH DAVID ANSTEAD, C.I.E., I.A.S.

BY

## SIR FRANK NOYCE, Kt., C.S.I., C.B.E., I.C.S.

Before these lines appear in print, there will have disappeared from the Madras Civil List the name of one whom the Agricultural Department in that Presidency could ill afford to lose—Rudolph David Anstead, its Director of Agriculture, who retired under the age limit on June 2nd of this year. Born on June 2nd, 1876, Mr. Anstead was educated at Giggleswick Grammar School and Christ's College, Cambridge, of which he was a scholar and prizeman. After graduating in Natural Science, he joined the Agricultural Department in the British West Indies, in which he held successively the posts of Research Chemist in Barbados, Sugar Chemist in the Imperial Department of Agriculture and Superintendent of Agriculture, Grenada. His experience in the West Indies marked him out, on his transfer to the Indian Agricultural Service in 1909, for the newly created post of Deputy Director of Agriculture for the Planting Districts in Southern India. Excellent as was the work he did in that capacity, it was of such a specialised character that his appointment as Director of Agriculture in 1922, in succession to Mr. H. C. Sampson, came as somewhat of a surprise. It did not, however, take long for him to convince those who had been sceptical of the wisdom of the appointment that it was thoroughly justified. When he took charge, the fortunes of the Madras Agricultural Department were at a low ebb. It had lost very heavily by retirements on proportionate pension and its morale had been badly shaken. Anstead was not dismayed. He faced the position with confidence and inspired confidence in others. He had in fullest measure that essential qualification for the Headship of a Department, the gift of getting the best out of all who worked under him and of persuading those above him, Secretaries, Ministers and the Legislative Council, to give him what he asked for his Department. Of his popularity with the members of his staff and of the regard in which he was held by them the writer of this note can speak from personal experience of the annual gathering of the agricultural clans at the Coimbatore College. Of his merits as a colleague the writer can also speak from personal experience of some eighteen months' duration, during which the only subject of disagreement was in regard to the expediency of prohibiting the export of bones and fish manures! An able speaker and a ready writer, Anstead was able to advance the interests of his Department and still more those of the agriculturists, whose benefit is the only justification for its existence, both by lectures and addresses

and in the columns of the Madras newspapers. His last important official act was the formulation of a detailed scheme for the reorganisation and development of the Department to which he had rendered such yeoman service, and it was a matter of great gratification to him that it had been accepted in principle by the Madras Government before he left India on long leave preparatory to retirement in September, 1929. The C. I. E. conferred on him in January, 1927, was most worthily earned. Always a keen sportsman, he was, until his eyes began to give trouble, a cricket and tennis player much above the average, and the greatest regret of his life was that he just missed his "Blue" at Cambridge.

The Madras Agricultural Department would, we feel certain, feel aggrieved if this brief tribute were to conclude without a reference to that most gracious of hostesses, Mrs. Anstead, who made all its members welcome wherever her headquarters for the time being but notably at that appropriately named house, Banstead, on the Nungumbaukum High Road, in Madras City.

# THE INTRODUCTION OF CRUDE-OIL TRACTORS IN INDIA.

BY

WYNNE SAYER, B.A., I.A.S.,

*Officiating Imperial Agriculturist, Pusa.*

The use of tractors in India for farming, road grading and general haulage has developed with great rapidity during recent years, and now in place of the principal line of work being the introduction and popularisation of kerosine tractors, we are faced with the immediate question whether we shall continue with the present eminently satisfactory kerosine oil tractor, or take a big step in advance and cut down working costs by turning our attention to the crude-oil tractor, despite its being a comparatively novel form of prime mover to this part of the world. The advent of the kerosine tractors into Indian conditions was heralded by the motor car, and the majority of persons were already familiar with the petrol engine and its peculiarities, which, therefore, really presented very little that was strange or unusual when appearing under the guise of a kerosine tractor.

The position of the crude-oil engine is, however, quite different. As a prime mover this tractor comes in advance of the crude-oil motor car, and it will be necessary to go back for a short time into the history of the past to make clear where the present crude-oil tractor has been developed from.

The first gasoline-driven Otto cycle engine came into existence on a commercial basis in 1876, and this was the virtual beginning of the internal combustion engine age. Numerous improvements were effected during subsequent years, and 1891 saw the introduction of kerosine as a fuel for this type of engine. The Royal Show at Manchester in 1897 provided the first oil-engined agricultural locomotive, and an Ivel tractor with a two-cylinder horizontal petrol engine of 14 B. H. P. was exhibited at the Royal Park Show in 1903.

All such tractors remained in the Show stage only until the Great War when the necessity of speeding up food production and the replacement of horses on the land brought in a large number of light tractors for kerosine or petrol of numerous designs, chief among which was the Fordson.

The first Fordson demonstrated in India on a proper agricultural test was worked at Pusa in 1919, and, although most of the essential parts have been replaced, the main portions of the design are still working. Subsequent years have seen an advance in general efficiency and reliability which has culminated in a kerosine tractor

which is practically the last word in cheapness of construction and excellence of design. This very excellence has made it clear to all working on the subject that only by the utilization of a cheaper fuel could further considerable economy in working costs be achieved, and this led to the introduction of the crude-oil tractor. The principle of the heavy or crude-oil engine has been based on the fact that crude-oils can be exploded easily under compression—and the principle of compressing air to some 500 lbs. per sq. in. and pumping in oil through an atomiser located in the cylinder head enabled the magneto, sparking plugs and carburettor of the ordinary motor engine driven by kerosine or petrol to be dispensed with—as 90 per cent. of the breakdowns in this class of engine are located in the carburetion or ignition systems, and thus much greater simplicity of working was achieved. Further by controlling the stroke of the fuel pump it was possible to reduce the amount of fuel for light loads and to increase for heavy—thus producing an engine almost as flexible as a steam engine and the same capacity for taking up a load at a steady speed, while exhibiting a marked economy in fuel consumption. In addition, the ordinary types of Diesel fuel oil cost about 4-5 annas only per gallon and thus afford a tremendous economy in fuel costs and their consumption per brake horse power per hour is less than the quantity of petrol or paraffin used in the ordinary tractor.

With all these advantages the question at once presents itself—why is the Diesel Crude-Oil Engine not universally adopted ?

The answer is threefold :—

1. It costs at present considerably more to build.

2. In the mind of the general public the idea is still firmly implanted that the crude-oil engine is a terror to manipulate. This view has grown up as a result of the behaviour of the original Diesel engine which sometimes (owing to trifling adjustments being out of order) refused to start for hours. Further research and improvement of design has eliminated most of this trouble in the new designs, but the idea still persists, and one of the chief points it was necessary to demonstrate in our tractor display was the ease with which the tractor could be started.

3. The change can only be expected where kerosine oil is expensive. In countries where kerosine is very cheap, makers of tractors can naturally see no reason to change over to crude, and scrap large plants and expensive machinery.

Now having dealt with the main problem, let us proceed further and examine the two types of crude-oil engines which are, at present, being used.

*The first type.*—This is a four-cylinder, high compression, cold-starting type engine, usually operating on the Otto cycle with inlet and exhaust valves with a small ignition chamber on the cylinder head in which the atomiser is located. Ignition commences in the small chamber and spreads to the large maintaining combustion

pressure on the piston well down the stroke. The atomiser is a highly specialised piece of machinery and the objection to this type of engine is that the fuel injection gear generally comprises a number of small accurately fitting parts which require very careful handling and skilled attention when adjustments have to be made. Further, the correct setting of the fuel injection parts is very important and small errors affect the working results, as the slightest error in fitting together after cleaning will put everything out. It is hardly likely that such an operation will be able to be done in the field amid dust and dirt, and though the cheapness of working and the efficiency is undoubtedly present, yet the absolute simplicity which is so essential for machinery which has to work in isolated areas is not yet attained and the cost price is apt to be high due to the extreme degree of accuracy required in manufacturing and to the royalties which have to be paid to Continental patentees of the cold-starting type of engine, which serve to make the cost of the latter considerably more than that of the low compression two-stroke type which comprises the second type. A tractor of this type is about to be placed on test.

*The second type.*—This is the horizontal, valveless, two-stroke crude-oil engine generally of a single cylinder type with hot bulb ignition adapted for tractor work. Here we have a design which has already proved itself most reliable in stationary oil engines—is simplicity itself, and can be, and is, handled by the ordinary mechanic, is extremely economical in working and costs very little more than the kerosine tractor. It has a few points which require knowing, but its slow engine speed, exceptional simplicity and general reliability seem to mark it out as eminently suitable for agricultural work.

The tractor problem at Pusa having reached the stage referred to in para 1, *i.e.*, we possessed a kerosine tractor which did not seem capable of any further improvement and by its very efficiency and cheapness forced our attention to the possibility of economy in other directions. We decided to purchase a crude-oil tractor of the second type and started a series of tests which would provide us with reliable data. Owing to the interest exhibited in the work of this tractor while under test, it was decided to give a demonstration of its work, control and fuel consumption over a period of three days. The report is given below. This report is by no means final. One of the first things to realise about all tractor figures is that no reliance can be placed on the performance of any tractor over a period of a few days only. An efficient garage staff can work a ' dud ' to perfection for a few days and the results of former trials in England and elsewhere bring this fact into great prominence. Nothing but a 2-year test will give one the actual figures you require and prove whether the makers' claims are substantiated in actual practice. Actual fuel consumption figures are always higher than those obtained on tests, and the amount of

work done on an ordinary working day is not up to that obtained in a trial, while small breakdowns and other causes of loss of time are usually conspicuous by their absence in the trial of a new tractor.

The crude-oil tractor demonstrated was a "Lanz Bulldog" semi-Diesel 15-30 H. P.—slow running, single cylinder, two-stroke type with hot bulb ignition, which has been working on the farm for the past six weeks. (Plate XXVIII.)

The objects of the demonstration were as follows :—

(1) To show the actual working and work done by the tractor under ordinary conditions.

(2) To show the method of starting, cleaning and general daily upkeep required.

(3) To definitely check off the actual consumption of fuel and lubricating oil and to obtain costs and quantities consumed under close observation.

The land selected was a clayey loam representative of the stiffest land in the farm area, laid out in strips of ¾ acre, about 10 yards by 360 yards, with several very heavy clay patches in the area.

Tractor was hitched to an old 3-furrow Ransomes RSLM share plough with P. C. 24 bodies and disc coulters purchased in 1921 (Plate XXVII). This plough was worked at an average depth of 6 to 9 inches.

The work done was satisfactory, but lacked the finish obtainable with the type of tractor plough which is now used with this H. P. tractor.

The listed H. P., 15-30, of the Lanz tractor does not correspond on actual test to the corresponding rating of American tractors. Hence it is not able to work with implements designed for the usual American tractor of a similar H. P. which is based on a ruling which only allows a certain percentage of the actual power to be given as the catalogue power.

The front wheels of the tractor require to be fitted with proper angle rims of 2½″-3″ depth; a distinct inclination on the part of the off-side front wheel to run out of the furrow was apparent and a tendency to crab, and the tractor when turning on worked land was liable to slide and drift.

The tractor was worked with a disc harrow 7½ ft. Roderic Lean (28 discs). It was evident from the pace at which it worked that an extra one foot spread could have been taken.

The behaviour of the engine throughout was excellent. The ploughing load was taken up in all but the deepest land on second gear without faltering. On three occasions in the stiff clay belts at 9 inches depth recourse had to be made to first

gear, but engagement was not required for more than 10 yards of run, when second gear could be re-engaged.

The starting times from cold are recorded below :—

| | |
|---|---|
| 20th November 1930 . . . . . . . | 15 minutes. |
| 21st November 1930 . . . . . . . . . . | 18 „ |
| 22nd November 1930 . . . . . . . . | 16 „ |

On the first day 0·47 inch of rain fell on the previous night, rendering a postponement for some two hours necessary.

*Exhaust*.—The exhaust remained absolutely clean when ploughing, and only smoked slightly on running light when turning at the headlands.

*Regularity*.—This was very good, and when it hit a bad patch of soil the tractor stuck to its work in a very remarkable manner. The power fell off somewhat towards the end of the second day. The exhaust parts and silencer had never been cleaned since starting (about 6 weeks). On attending to this on the second evening the normal power was shown on the third day.

*Cooling*.—This was very good in spite of the fact that the fan belt was on the slack side, very little make-up water was ever needed.

*Evenness of pull*.—The spring draw-bar gave excellent results.

*Overload release on clutch*.—This came into action when working the 10 ft. Baron disc harrow on the first day.

The figures given below show the total time worked with each implement, the area covered and the fuel and lubricating oil consumed. The costs of the same at Pusa are given together with the corresponding costs of kerosine oil.

STATEMENT SHOWING OUTPUT, CONSUMPTION AND COST OF CULTIVATION BY LANZ TRACTOR ON 20TH-22ND NOVEMBER, 1930.

*Total acreage.*

| | Time H. M. | Acre |
|---|---|---|
| 1. Ploughing . . . . . . . . . . . . | 6 59 | 6·00 |
| 2. Harrowing . . . . . . . . . . . . | 3 23 | 7·20 |

*Acreage per hour.*

| | |
|---|---|
| 1. Polughing . . . . . . . . . . . . . . . . . | 0·92 |
| 2. Disc-harrowing . . . . . . . . . . . . . . . | 2·12 |

### *Cost per acre.*

| | Rs. | | |
|---|---|---|---|
| 1. Ploughing | 1 | 9 | 4 |
| 2. Disc-harrowing | 0 | 10 | 0 |
| Cost per hour | 1 | 5 | 7 |

### *Consumption and cost of fuel, etc., per hour.*

| | | Rs. | | |
|---|---|---|---|---|
| 1. Crude Oil | 8 seers * | 0 | 9 | 4 |
| 2. Mobil Oil BB | 10 chs. | 0 | 6 | 8 |
| 3. Mobil Oil C | 3 chs. | 0 | 1 | 9 |
| 4 Kerosine Oil | 3 chs. | 0 | 0 | 7 |
| 5. Grease | 1¼ chs. | 0 | 0 | 7 |
| 6. Waste | ½ chs. | 0 | 0 | 2 |
| 7 Labour | | 0 | 2 | 6 |
| Total cost per hour | | 1 | 5 | 7 |

### *Cost of kerosine oil.*

| | | | |
|---|---|---|---|
| Per gallon *without freight* | 0 | 11 | 7 |
| Cost per seer (1 gall. = 3 srs. 14 chs.) | 0 | 2 | 11 |

### *Cost of crude oil.*

| | | | |
|---|---|---|---|
| Per gallon *without freight* | 0 | 3 | 3 |
| Cost per seer (1 gall. = 4 srs. 4 chs.) | 0 | 0 | 9 |

The general working costs over the period 11th to 31st October during which the tractor has been employed on the farm are given below :—

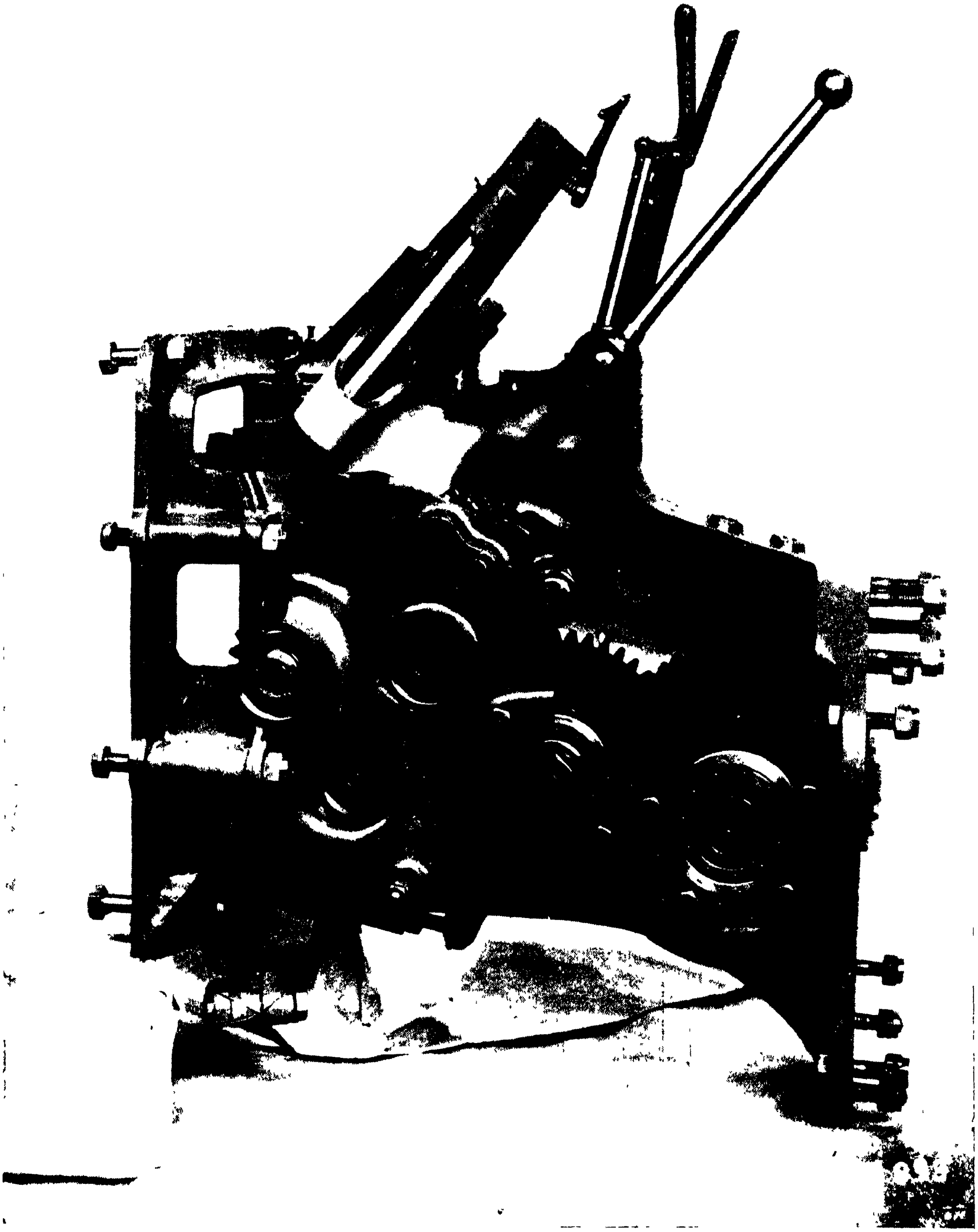
| | Rs. | | |
|---|---|---|---|
| 1. Disc-harrowing | 0 | 10 | 7 |
| 2. Grubbing | 0 | 10 | 3 |
| Cost per hour | 1 | 2 | 2 |

No difficulties have been encountered. The ordinary *mistri* staff employed here to work our other tractors has started and worked the crude-oil tractor without difficulty.

Decarbonisation and cleaning of the air-filter and exhaust parts is necessary, say, every 50 hours' running or once a week, and the fusible plug should be withdrawn and cleaned each morning. No difficulty is experienced in these operations and the time taken is one hour for the weekly cleaning. The cost of kerosine shown in the working figure refers to oil consumed in the starting blow lamp.

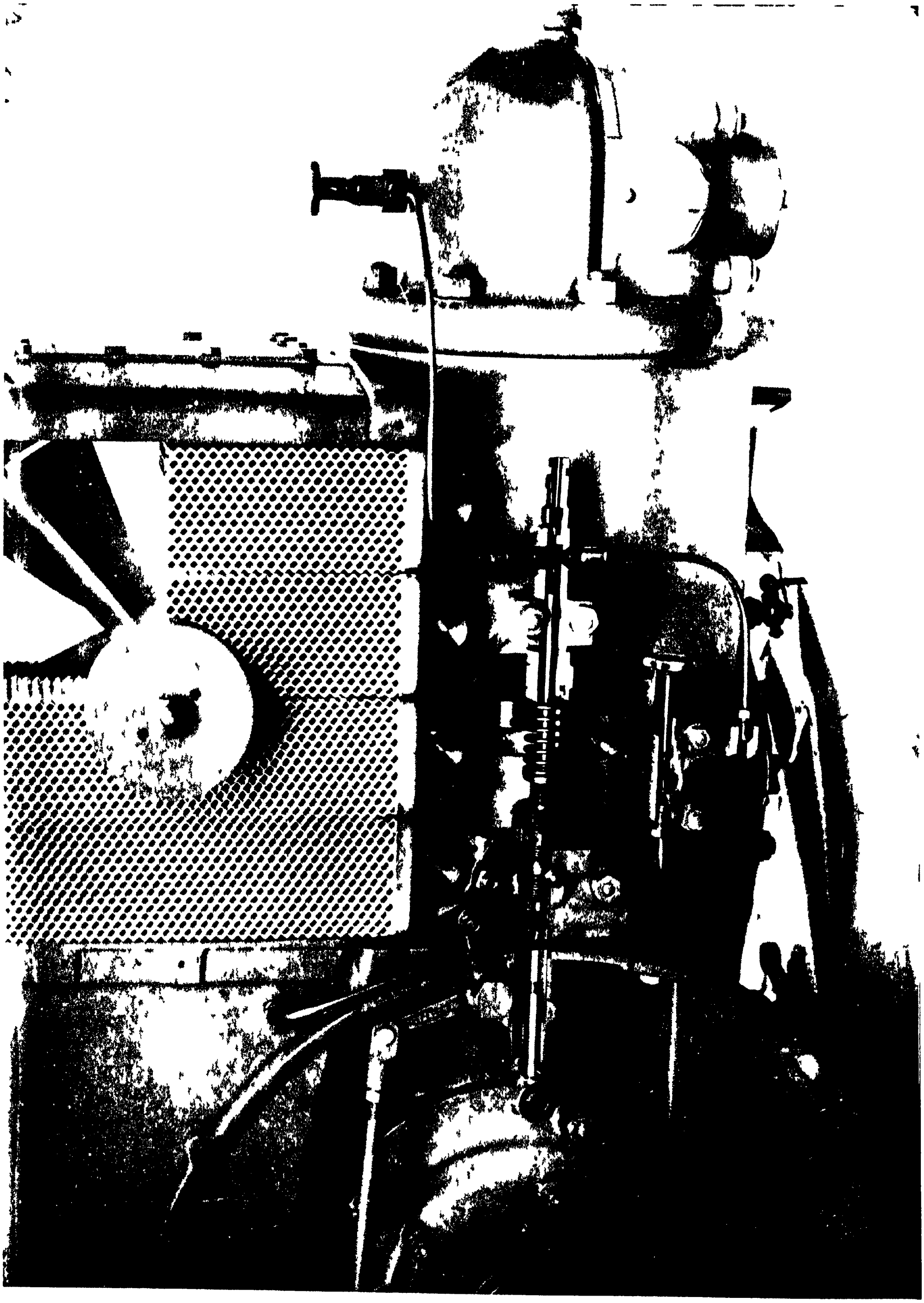
*1 seer = 16 chs. = 2 lbs.

PLATE XXXII.



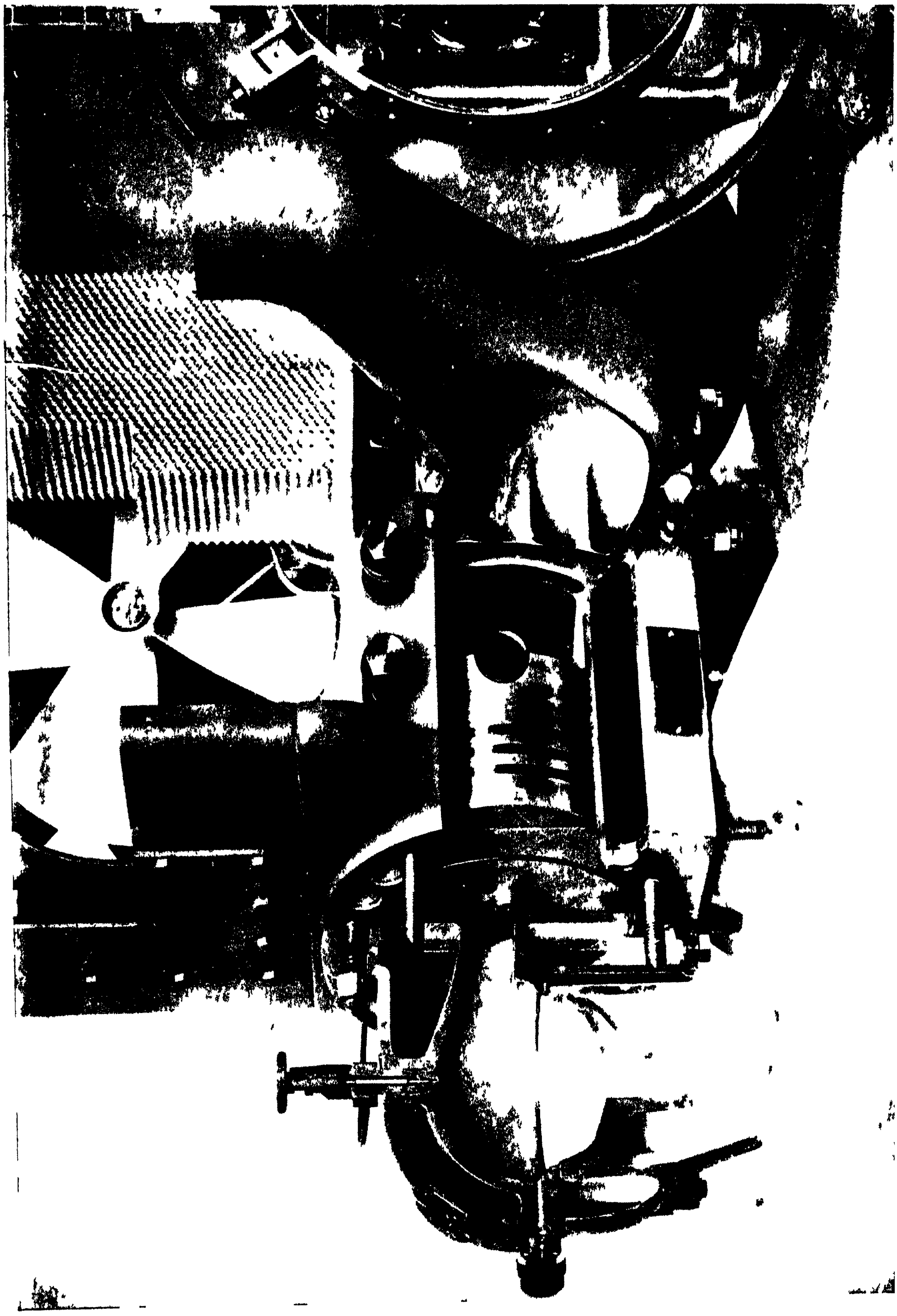
Lanz Bulldog Tractor. A side-view of the internal arrangement in gear-box. The steering wheel has been removed in the illustration.

PLATE XXXI.



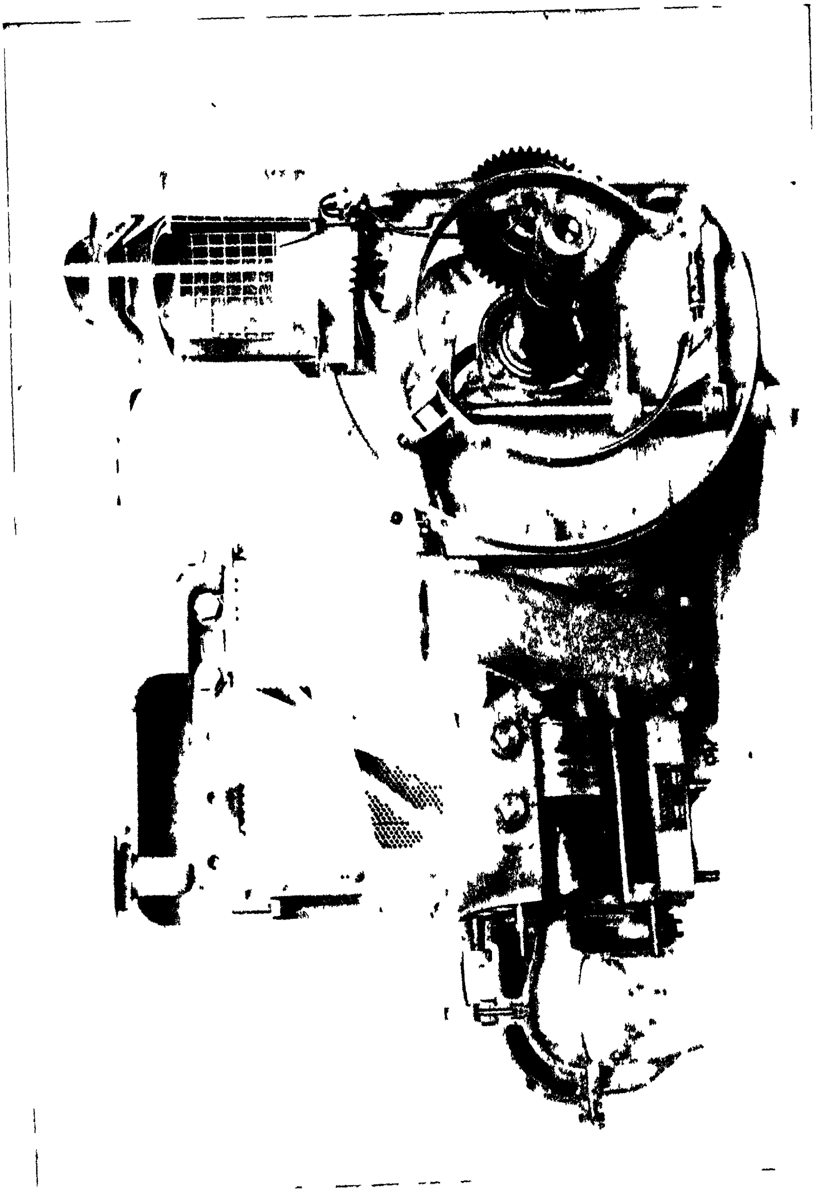
Lanz Bulldog Tractor. Mechanism of Fuel Supply and Fuel Pump shown in Section.

PLATE XXX.



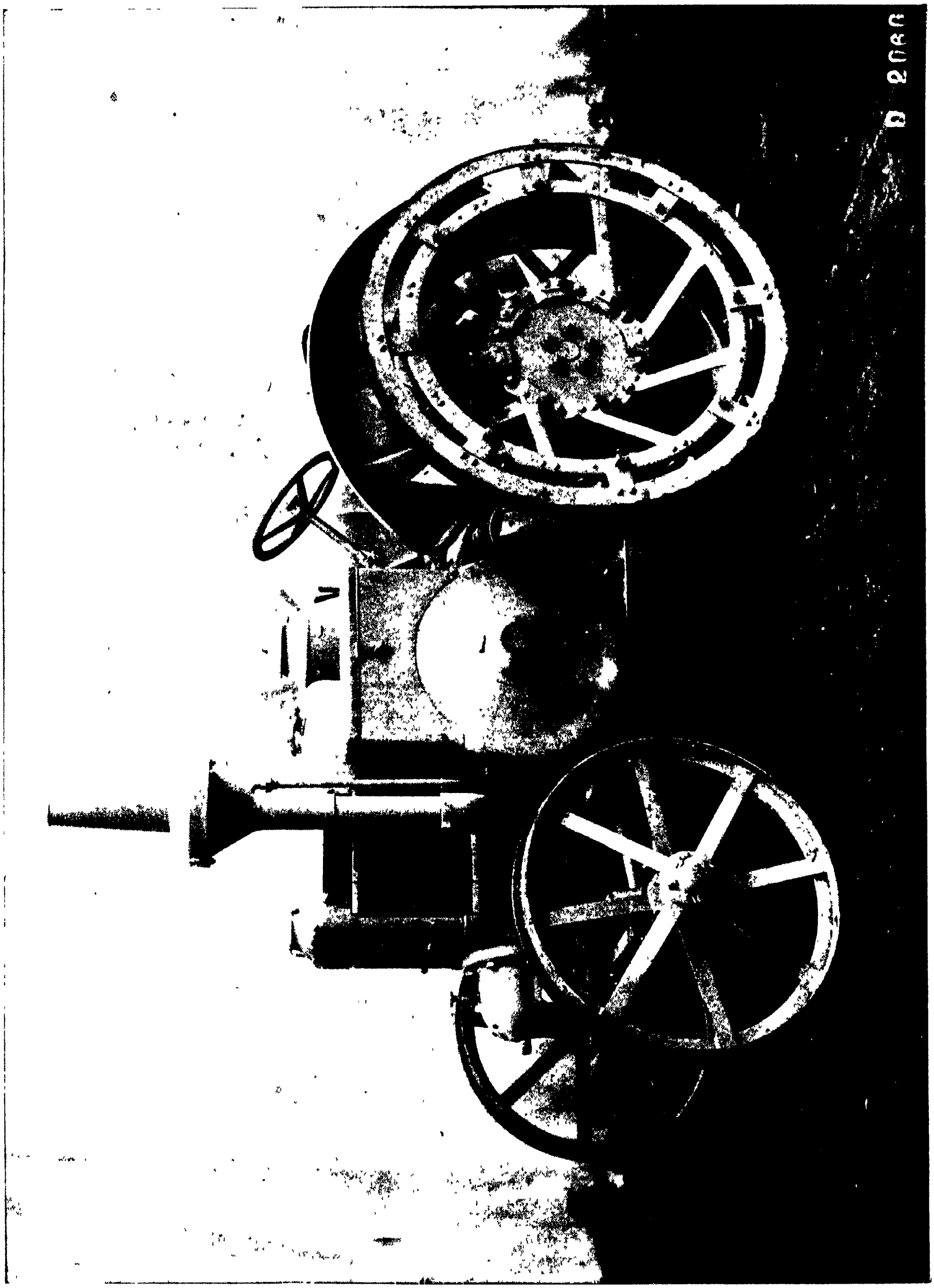
Front part of Lanz Bulldog shown in section. Hot bulb and fusible plug at left end.

PLATE XXIX.



Lanz Bulldog Tractor. Arrangement of cooling system air filter cylinder with piston cylinderhead and hot bulb shown in section, with exhaust cover, silencer and pulley removed.

PLATE XXVIII.



Lanz Bulldog Semi-Diesel Tractor 15-30 H.P. (Rear wheels fitted with Road-tire).

PLATE XXVII.

Lanz Bulldog Tractor hitched to a Ransome's 3-furrow self-lift plough at work on Pusa Farm.

The tractor will now continue to work in the ordinary farm routine for the next three years to enable us to collect data as to upkeep and repair costs for comparison with the other tractors working alongside.

Samples of the fuel oil used were on view at the demonstration.

Three points were clearly shown in the demonstration.

1. Marked saving in fuel costs per acre.
2. Absence of any difficulty in starting or control.
3. Necessity for implements designed to the actual H. P. of the tractor to obtain optimum results, the advertised H. P. being different from the American rating to which the buying public is accustomed.

Illustrations (Plates XXVII—XXXII) are given, showing the tractor and the actual working parts which require attention.

The hot bulb and the fusible plug are shown in Plate XXX ; both are removable at short notice in the event of replacement being necessary.

It must also be clearly understood that the engine, being a single cylinder, two stroke running very slow, is capable of going into reverse without warning when idling, and care must be taken on re-starting the tractor when engaging gear to see if this has happened, otherwise the tractor will run back on the implement and damage both.

As the scavenging stroke is also the explosion stroke, it is obvious that both inlet and exhaust ports must be kept quite clear as the exit of the spent gases and the entrance of the clean air are both made without compulsion ; for this reason it is essential to clean the exhaust and air-filter every 50 hours' working.

# GRAIN MARKETS IN THE NORTH OF THE CENTRAL PROVINCES.*

BY

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## INTRODUCTION.

The northern districts of the Central Provinces, embracing the two plateaux and the intervening valley of the Nerbudda, constitute the well-known wheat belt of the Province. The long and narrow valley of the Nerbudda, bounded on the north by the Vindhyas and on the south by the Satpuras, "formed of deep alluvial deposits of extreme richness" extending over an area of 200 miles by 20 miles, is one of the most fertile tracts of the Province, and is, in the winter, one huge, unbroken sheet of wheat. As the land rises on either side and the soil becomes poor and rugged, wheat gives place to the hardier lesser millet. The area under wheat in this belt during 1929-30 amounted to 2,091,778 acres, representing 65 per cent. of the total of 3,231,533 acres for the whole of the Central Provinces and Berar. In addition to wheat there is in this belt a very large area under pulses and oil-seeds.

The average production of wheat alone in this belt amounts to more than 15,688,335 maunds in a normal year. Its predominant position in the production of grain and pulses is evident in the fact that in the wheat trade it supplies 75 per cent. of the total exports from the Central Provinces and Berar, and 70 per cent. of the intra-provincial trade. The corresponding figures for pulses are 50 per cent. and 60 per cent. respectively.

The most important marketing centres are Kareli, Gadarwara, Piparia, Itarsi, Harda, Jubbulpore and Sihora. The total quantity of business done in some of these wholesale markets during the three busy months of April, May and June amounts to several crores of rupees.

## THE GANJ.

The market place is known in the vernacular as the *ganj*. The *ganj* is generally an open square bordered by the business premises of merchants and commission agents. There are no covered sheds or paved floors to accommodate the grain in inclement weather. Every *adathiya* claims the space in front of his shop up to a

*Read before the Agricultural Section of the Indian Science Congress, Nagpur, in January 1931.

convenient distance as his own, and he keeps that space clean and plastered with cow dung.

The *ganj* is the property of the Municipality or "Notified Area Committee" which generally charges a small fee for allowing grain to come into it. The Committee also makes some money by licensing the commission agents and weighmen.

The organization of the market is extremely simple. The commission agents known as *adathiyas* and *dalals* are the central figures. They are the intermediaries through whom the buyer and the seller must act. In theory there is nothing to prevent a man from going to the market and offering his grain for sale without enlisting the help of the *adathiya*, nor is there anything to prevent an intending buyer from bidding independently. But in practice no such step is ever taken. Nobody dares to break through the immemorial custom and convention of the market. There is no market committee or any other similar organization to regulate marketing procedure. When any dispute arises an emergency *panchayat* is formed from amongst the by-standers to deal with it. In every market custom has established a recognized method of dealing to which everybody adheres.

### THE "BEPARI" AND VILLAGE SALES.

The *beparis* or itinerant traders who go from village to village and buy up the small surplus of individual cultivators occupy at the present time an important place in rural trade. In all markets these *beparis* are responsible for a large part of the arrivals. At Kareli they are responsible for 50 per cent. of the grain brought into the market, at Gadarwara for 30 per cent., at Piparia 90 per cent., and at Sihora for 50 per cent. But there is an increasing tendency on the part of the cultivators to go to the market themselves. This is particularly the case with cultivators living in the neighbourhood of markets and in areas where communications are good. Where the country-side is well served with a good system of roads, with bridges across rivers and *nalas*, there the cultivators go to the market unhesitatingly. Where communications are defective, the cultivator sells his produce in the village, unless he has a large quantity of produce and bullocks sturdy enough to draw heavily loaded carts over rough roads. The condition of the means of communication in this tract is none too good although it is steadily improving, and although all but a few villages in the jungly tracts are within easy reach of the railway. The main defect is brought out in the following extracts from the Settlement Forecast Report of the Hoshangabad District, 1913-18 :—"The communications of the district are excellent in the open season ........ But as soon as the monsoon breaks, all this is changed. The heavy alluvial soil becomes a morass impassable to wheeled vehicles and for four months communication with the market is practically

suspended. The result is that those cultivators—and they form the majority—who cannot afford to hold up their crops for that length of time at the risk of deterioration, have to thresh and market it during April and May at whatever prices may be ruling."

The *beparis* have very little capital of their own. Every *bepari* keeps a running account with an *adathiya* who advances him money whenever required. These advances are only for short periods—two or three weeks. If a *bepari* does not bring grain to the value of the advance taken within a month, interest at 12 to 18 per cent. is charged. The *beparis* do not advance money to cultivators at sowing time, nor do they buy standing crops. They simply buy grain for cash.

It is often said that the *bepari* is an unwelcome parasite on the cultivators, depriving him of a certain portion of his profits. But it must be remembered that the great majority of the cultivators have such a small surplus for sale that it is often not worth their while to go long distances over bad roads to market. It is true that in the market they will get a higher price than in the village, but the difference is not worth the time and the trouble. Enquiries made in these markets show that the *bepari* does not make fabulous profits. After meeting all expenses he is content if he makes a net profit of 8 to 12 annas per *mani*. That is the amount that the cultivator stands to gain by personally going to the market. The belief amongst the cultivators is that they might secure only about 2 to 3 per cent. more, and this they are prepared to forego for an earlier realization of cash in the village.

Again, the ordinary cultivator feels a stranger to the methods and procedure of the wholesale market. The weights and measures confuse him ; he is accustomed to reckon in measures, while most of the wholesale markets transact business on the basis of weights. Correlating the two is for him a difficult matter. The cultivator who takes a certain measured quantity to the wholesale market finds himself considerably out of his reckoning when his grain is weighed. This causes a certain amount of suspicion that he is being cheated. He would willingly forego a small extra profit rather than stand all this strain. Thus, looking at the question from all points, one is inclined to think that the loss which the cultivator incurs by selling in the village is not more than 5 per cent., but this sacrifice saves him a lot of worry and trouble.

The question how far indebtedness prevents cultivators from going to the market is rather difficult to determine. But it appears that the old system of *bandhor* whereby the cultivator was given a loan at sowing time on condition that he sold the crop to the creditor at harvest, is fast disappearing. The village money-lender is not so keen for grain to-day as he was some years ago. The development of easy means of communication has made the storing up of large quantities of grain unnecessary and

unremunerative. If there is a certainty that the advance taken from him will be returned in due time, he does not seek to prevent his client from taking the produce to the wholesale market for sale.

## The Sale.

The method of settling the price varies from market to market. At Kareli, Gadarwara and Itarsi, the *hatta* system is used. The system at Piparia may be described as one of "quoting on samples". At other places the price is settled by auction or *lilam*. *Hatta*, as the name indicates, is a system in which the transactions are settled by the secret manipulation of the *hath* or hand. The system works as follows :—

The grain is heaped on the ground or kept in open bags. Then the *dalal* comes and stands before the heap and asks the buyers for their offers. One by one the buyers offer their rates, not openly but secretly, by means of finger manipulations with the *dalal*. The *dalal* holds in his hand a piece of thick cloth covering the fingers and the palm. If a buyer wants to offer Rs. 15-4-3 he pushes his hand underneath the piece of cloth and says loudly "Rs. 14" and grasps one finger of the *dalal* with an upward jerk. This is supposed to mean Rs. 14 + 1 = 15. Then he shouts "anna" and grasps four fingers, which means four annas. Then he shouts "pies" and grasps 3 fingers. Thus, by the secret manipulation of the fingers, each bidder offers his rate unknown to others. Each bidder can make only one offer and no other chance is allowed. The price offered is for the *mani* or *kudo* or *maund* according to the standard current in the market : or it may even be on the basis of so many seers per rupee, as at Jubbulpore. When all have offered, the *dalal* declares openly the highest bid and the bidder's name.

This *hatta* system is very popular in certain markets. The merchants are full of praise for it perhaps because it is a system which secures several advantages to the professional trader. The ordinary cultivator, however, seems to look upon what goes on underneath the cloth with a sense of respectful awe, and if one asks him for his opinion on the system, he says he knows nothing about it. He simply accepts without question the declaration of the *dalal*.

The system might conceivably work all right if the *dalal* were always anxious to get the best price for the seller. But this is not always the case. The *dalal* is only an agent of the *adathiya* and the *adathiya* is always the buyer, and the *dalal* can help the *adathiya* to a cheap bargain in many ways. For example, suppose one bidder offers Rs. 25 and the next highest offer is Rs. 24-4-0. If the top-bidder is a friend of his, the *dalal* can easily help him by the simple expedient of declaring his bid at a figure just above that of the next highest bidder, say Rs. 24-4-3 instead of

Rs. 25. He thus saves his friend Re. 0-11-9. There is no way of detecting or controlling this species of cheating.

The method of "quoting on samples" practised in Piparia market is as follows :—

The grain is not heaped on the ground but remains packed in bags or carts as it arrived. The *adathiya* collects a small sample of about a pound from every lot that he has for sale. When the owner of the grain gives the sample to the *adathiya* he cleans it a little by blowing of the dust and picking out the bigger stones. The samples are then taken round to each *adathiya* in the *ganj*, and the grain is offered to the man who bids the highest price. The offerer then proceeds to compare the grain with the sample. This is a source of endless higgling. The buyer will say that the grain is not up to the quality of the sample and will reduce his offer. If the reduction is not acceptable to the seller, the buyer may declare the bargain off. But if this dispute over quality starts after the grain has been heaped on the ground, a *panchayat* is called and its decision is final.

In this system, as well as in *hatta*, the privilege of buying in the market is confined to the professional commission agents—the *adathiyas* and *dalals*. Any other person who wants to buy must buy through them. The secrets of finger manipulations in *hatta* are only known to the class of professional middlemen. *Hatta* tends to perpetuate the monopoly of the merchants in the matter of buying in the market. From the view-point of the merchant *hatta* is a good system, while for the cultivator open auction is the better. In the system of quoting on samples the samples are taken only to the shops of established *adathiyas*. When a layman wants to buy he goes to an *adathiya* and requests him to buy for him.

Sale by auction, or *lilam*, as it is known in the vernacular, is so common that it needs no description. At Sihora sale is by open auction, but the bid is on the basis of so many seers per rupee.

## THE MIDDLEMEN OF THE MARKET.

We have already alluded to the fact that the commission agents are the central figures in these markets and that they fall into two classes (1) *adathiyas* and (2) *dalals*.

(1) The *adathiya* is the more important person of the two everywhere. In some places like Piparia and Itarsi there are no *dalals* ; there the *adathiya* manages the whole business. The *adathiyas*, as a class, are the chief buyers in the markets, and they export grain in large quantities to places outside the Central Provinces. They also buy on behalf of persons like private local purchasers, on payment of a small commission. Thus they buy, and sell, and act as commission agents. An *adathiya* may be either a *kutcha adathiya* or a *pucca adathiya*, or both, according to the mode

of business he practises. The business of the *kutcha adathiya* is simply to get the grain sold in the market, and the remuneration for that is known as *kutcha adath*. It varies from eight annas to one rupee per hundred rupees of transaction. When the *adathiya* purchases on behalf of somebody else he is a *pucca adathiya*, and the remuneration for that is known as *pucca adath*. The same man generally does both kinds of transactions and receives both *kutcha* and *pucca adath*. For example, the *adathiya* buys on behalf of A the grain belonging to B. He receives *pucca adath* from A and *kutcha adath* from B. *Pucca adath* is charged at a higher rate than *kutcha adath*, about 12 annas to Re. 1 per hundred rupees. The *adathiyas* are in constant communication with outside merchants and frequently buy on behalf of merchants in Bombay and other places. In such transactions they get their *pucca adath* and all expenses besides. But when the *adathiya* buys of his own accord and sells later to another person he cannot charge any *pucca adath*. He then charges the highest rate current on the day of the sale. This is mere speculation, buying in the hope of selling when prices rise. This forms a large part of his business. He buys large quantities of grain and stores it in huge *bhandas* for months together in the hope of selling when prices rise. The cash credit advance system of the Imperial Bank, and now of the Allahabad Bank, by which on the security of the grain stored in a recognized place a merchant can get from these banks an advance up to 75 per cent. of the value of the stored produce, enables him to buy much larger quantities now than in the past. The *adathiyas'* buying in the market and their speculating business increases the demand in the market and tends to raise the price of the commodity.

The *adathiya* performs a very useful function in the market. He has his permanent establishment of coolies, weighmen and the appurtenances of the trade, all of which is at the disposal of his clients. More than all, he is a financier and it is in this respect that he is most useful. When a bargain is settled through him, he pays cash to the seller the same day and enables him to clear off without unnecessary delay. The purchaser is given some time to pay—three to seven days. When grain is sent out to merchants for large sums he accepts *hundis*. Thus, operating through the *adathiya* is beneficial to both the seller and the buyer. His business is a species of discounting and the commission he charges is mostly a fee for this discounting.

The *adathiya* takes no share worthy of mention in the financing of agriculture in these parts. He sometimes lends money to cultivators or *malguzars* who are longstanding clients of his. He does not do this with the cultivators in general.

(2) Generally the *dalal* is a broker whose function it is to bring the buyer and seller together. He must hold a licence from the municipality. The *dalal* is not a

capitalist; he does not take upon himself the responsibility to pay the seller before the buyer has made payment; he has no concern whatever with accounts and payments. He has no establishment of his own but works with an *adathiya* to whom he does his best to attract sellers. His business is with the actual sale, in which he is supposed to be acting on behalf of the seller, seeing that he gets a fair bargain and that he is not cheated over weighing and measuring. For these services he receives *dalali*.

## EXPENSES OF MARKETING.

An accurate estimate of the general expenses of marketing is rather difficult to make. They vary from market to market and although most of the items of expenditure are fixed and laid down by custom for the market as a whole, they are so elastic that they often vary according to the nature of the commission agent and the seller. A very clever seller might escape some of the more unreasonable exactions and a good-natured commission agent might deal more liberally towards his clients.

A fair percentage of the so-called "market expenses" has nothing to do with the actual marketing of the produce. Some of them go to charity, others are social contributions, but whether for social or charitable objects the giver has little say in the giving. They have become so much bound up with the other and legitimate market expenses that nobody questions the levying of them.

The market expenses can be brought under three heads:—

(1) Expenses incidental to marketing.
(2) Charity.
(3) Other charges.

### 1. *Expenses incidental to marketing.*

(*a*) *Octori.*—This is levied only in big towns like Itarsi and Jubbulpore. At Itarsi it is four annas per cart, irrespective of the quantity contained in the cart. At Jubbulpore it is two annas per bag.

(*b*) *Adath.*—This is the remuneration of the *adathiya* for service rendered by him. It is eight annas to one rupee per hundred rupees.

(*c*) *Dalali.*—This is the remuneration to the *dalal* for his services. It is in some places six pies per *mani* of grain, in others four annas per hundred rupees.

(*d*) *Majuri.*—This is a general term which comprises remuneration given for the services of the various labourers in the market. It includes unloading, *kattai* or opening out bags, *dheri* or heaping, *saphai* or cleaning, *chadai* or putting the produce

into the scales, *shilai* or stitching up bags, etc. The amount of this charge varies from market to market. On the average it is about one anna per bag.

(*e*) *Tulai* or *mojai*, *i.e.*, weighing or measuring.—Measuring is paid for at the rate of nine pies to one anna per *mani*. But in most places the weighman is paid at the rate of eight annas per hundred rupees worth of grain.

(*f*) *Muthi*—The term literally means a handful. A handful of grain is given as remuneration in kind or as an additional payment in kind for various services. A *muthi* is two to six *chataks*.

## 2. *Charity.*

(*a*) *Dharmadav.*- This is a contribution to the charity fund of the place. Charity is, in theory, optional but long established custom has now made this a compulsory contribution. The *adathiya* deducts the amount from the price when he makes payment. The deduction under this head varies from three to nine pies per bag. It is sometimes collected from both the buyer and the seller.

(*b*) *Ramlila.* In most of the places there is a "*Ramlila* fund", the contribution to which varies from three pies to one anna per seller.

(*c*) *Temple fund.* In some places there is a separate contribution for temples. This is always in kind and the representative of the temple collects it on the spot. At Gadarwara a *muthi* per heap of grain is given to each of the five important temples of the place. A *muthi* here varies from four to six *chataks*.

(*d*) *School fund.*- At Kareli there is a school fund to which every seller is made to pay three pies per *mani* of grain.

(*e*) *Goshala.* At Itarsi the seller has to pay six pies per heap towards the maintenance of a *goshala.*

## 3. *Other charges.*

There are a number of small deductions, some in cash, some in kind, which appear to be extremely unreasonable. The total amount involved may not be much, but all the same the existence of these exactions is a legitimate grievance of the cultivator, the removal of which would go a long way to make the wholesale markets more popular.

(*a*) When settling accounts the seller is offered currency notes by way of payment. Currency notes are of little use to the rural folks and naturally they ask for coin. A deduction of four to eight annas per hundred rupees is then made for paying coin.

(*b*) *Bhunj.*—This is said to be a deduction for procuring small change to square the accounts and for distribution to the coolies. This is six pies per seller.

(c) *Muddath.*—This is a deduction of four annas per hundred rupees common in Piparia for settling accounts and making payments to the seller on the day of the transaction, the normal time for making payment to the seller there being within three days after the transaction.

(d) *Bhanji.*—This is an exaction in kind amounting to two *pavs* (8 *chataks*) of grain per heap taken by the *adathiya* as a sample.

(e) *Likhai.*—This is a *muthi* given to the clerk of the *adathiya* for keeping accounts.

(*f*) *Chithiwala.*—This is another *muthi* given to the personal servant of the *adathiya.*

(*g*) *Swaraj Fund.*—This is a new collection introduced this year by the *adathiyas* of Jubbulpore. It is three pies per bag.

Detailed lists of the expenses of the seller in some of the important markets are given in the appendix. On an average these work out to about ten annas per *mani* of grain.

## Weights and Measures.

Of all the problems connected with marketing in this part of the country, what defeats one's powers of comprehension most is the inextricable tangle of weights and measures. There is an amazing variety of weights and measures in use in these markets. One hears of *khandi, kudo, mani, paili paseri,* seer, and so on. Then there are the *bada kudo, chota kudo.* The quantities represented by these vary from market to market, from village to village, and according to the kind of grain measured. In short, in no two places will any of the above-mentioned weights and measures have the same significance. For example, the quantity represented by a *kudo* varies as follows :—

| | |
|---|---|
| 1 *kudo* in Jubbulpore . . | 5 seers. |
| Do in Sihora . . . | 4 ,, |
| Do in Gadarwara (small *kudo*) | 5 seers, 1 chatak . |
| Do do (large *kudo*) | 9 seers. |
| Do. in Hoshangabad . . | 9 ,, |

These are for grain. For oil-seeds the weights and measures used have a different significance. In Itarsi market, where they use a *kudo* for measuring, the quantity represented by the *kudo* varies with the kind of grain as follows :—

| | |
|---|---|
| 1 *kudo* for wheat *Pissi* . | $9\frac{3}{4}$ seers. |
| 1 ,, ,, ,, *Lal* . . | 10 ,, |
| 1 ,, ,, *Juar* . . | 9 ,, |
| 1 ,, ,, Gram . . | $9\frac{1}{2}$ ,, |
| 1 ,, ,, Linseed . . | 8 ,, |
| 1 ,, ,, *Til* . . . | 7 ,, & $1\frac{1}{2}$ *pav.* |

In some markets the practice is to weigh the grain. In others the grain is measured by a *kudo* or *paili.*

Weighing is done either on the beam-scale or on small hand-scales. At Jubbulpore the accepted standard is the maund of 40 seers but they do the weighing by using a *paseri* of five seers. The task of converting all these local weights and measures into some well-known standard for comparision is a hard one for the unsophisticated villagers.

The confusion of weights and measures is confounding even to the shrewd *bepari* and he often loses, especially when prices tend to fall. This was particularly the case in 1930 when prices continued to fall steadily. In the villages round about Piparia they use a *paili* of 90 *tolas* and 192 *pallis* make one *mani*. In the wholesale market at Piparia the *mani* is of 200 seers, each seer being of 96 *tolas*. Thus there is a difference of 1920 *tolas* between the village and bazaar measurements ; the bazaar measure being bigger by that amount. With prices steadily falling, the difference between the price already paid in the village and the price realized in the wholesale market tends to vanish.

People in general prefer weighing to measuring as they realize that weighing is more constant and offers fewer opportunities for manipulation. If the *mojaiwala* or measurer has a particular leaning towards the buyer, he can always during measuring give the buyer more grain by certain tricks like pushing the *paili* with greater force into the heap, pressing the grain with his hand while filling, and by carrying some more grain over the fingers in the process of throwing. All this is done with such deftness and quickness that it is difficult for an ordinary person to detect. But it is said that, if the man who measures is so inclined, he can throw one extra *chatak* of grain in every *paili*. In fact, to keep him neutral it is the practice in some markets for the seller as well as the buyer to remunerate him.

The author wishes to express his indebtedness to Mr. J. C. McDougall, Deputy Director of Agriculture, Economics and Marketing, Nagpur, for his assistance in the preparation of this paper.

## APPENDIX.

### Expenses of the Seller.

1. *Kareli*—

| | |
|---|---|
| *Dalali* | 6 pies per *mani*. |
| *Adath* | 12 annas to one rupee per hundred rupees. |
| Cleaning | One anna per *mani* and one *muthi*. |
| *Majuri* | One anna per bag and three *muthis*. |
| Measuring | One anna per *mani* and one *muthi*. |
| *Dharmadav* | 4½ pies per *mani*. |
| *Ramlila* | One anna three pies per hundred rupees. |
| School | Three pies per *mani*. |
| For payment in coin | Four annas per hundred rupees. |

## EXPENSES OF THE SELLER—*contd.*

2. *Gadarwara*—

| | |
|---|---|
| *Dalali* | Six pies per *mani*. |
| *Adath* | Eight to 12 annas per hundred rupees. |
| Cleaning | Six pies per *mani*. |
| *Majuri* | One anna per bag and four *muthis* of grain. |
| Weighing | One anna per *mani*. |
| *Dharmadav* | Three pies per *mani*. |
| Samples | Five *muthis* of grain (of four *chataks* each). |
| Cleaning the ground | One *muthi*. (4 to 6 *chataks*.) |
| Waterman | One *muthi*. ,, |
| *Chithiwala* | One *muthi* ,, |

3. *Piparia*—

| | |
|---|---|
| *Adath* | Twelve annas to one rupee per hundred rupees. |
| *Majuri* | One anna per bag. |
| Weighing | One anna per bag. |
| *Dharmadav* | Two annas per hundred rupees. |
| *Ramlila* | Three pies per seller. |
| For payment in coin | Four annas per hundred rupees. |
| *Muddath* | Four annas per hundred rupees. |

4. *Itarsi*—

| | |
|---|---|
| *Adath* | Twelve annas to one rupee per hundred rupees. |
| Octroi | Four annas per cart. |
| Measuring | Nine pies per *mani*. |
| *Majuri* | One anna per bag. |
| *Dharmadav* | Three pies per *mani*. |
| *Ramlila* | 4½ pies per *mani*. |
| Temples | Two *pavs* of grain. |
| Servant of *adathiya* | One *pav* of grain |
| For payment in coin | Four annas per hundred rupees. |
| Sweeping the ground | One *pav* of grain |
| *Goshala* | Three pies per *mani*. |

5. *Sihora*—

| | |
|---|---|
| *Adath* | Eight to twelve annas per hundred rupees. |
| Octroi | One anna six pies per cart. |
| Weighing | Eight annas per hundred rupees. |
| *Majuri* | Six pies per bag or five *chataks* of grain per bag. |
| *Dharmadav* | 4½ pies per bag. |
| *Ramlila* | Six pies per hundred rupees. |
| For payment in coin | Four annas per hundred rupees. |
| *Bhunj* | Six pies per heap. |
| Sweeping the ground | One *muthi* (2 to 4 *chataks*). |
| Temples | Three *pavs* per bag (for 2 temples). |
| *Adathiya's* servant | 1½ *pav* per seller. |

## EXPENSES OF THE SELLER—*concld.*

6. *Jubbulpore*—

| | |
|---|---|
| *Dalali* | Four annas per hundred rupees. |
| *Adath* | Twelve annas to one rupee per hundred rupees |
| Octroi | Two annas per bag. |
| Weighing | Eight annas per hundred rupees |
| *Majuri* | Six pies per bag. |
| *Dharmadav* | Nine pies per bag |
| For payment in coin | Two to four annas. |
| *Bhunj* | Eight *chataks* of grain. |
| Waterman | Four *chataks* of grain. |
| Sweeping the ground | Four *chataks* of grain. |
| *Adathiya's* servant | Four *chataks* of grain. |
| *Dalal's* servant | Four *chataks* of grain |
| Swaraj fund | Three pies per bag. |

# POTATO STORAGE IN THE CENTRAL PROVINCES.

BY

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Many parts of the Northern Districts of the Province are important potato-growing centres where potato is chiefly grown as a *rabi* crop; the area under cultivation of this important food crop is capable of being increased, but the limiting factor is the difficulty of storing potatoes from the time they are lifted from the ground in February or March till the time of planting the seed (tubers) in June for the *kharif* crop and in October for the *rabi* crop. During this period of seven or eight months two entirely different climatic conditions have to be taken into account in evolving methods of storage. Soon after the tubers are harvested, the day temperature begins to rise, and ultimately in most parts the maximum day temperature normally rises above 100°F. and in some places even above 115°F.; whereas there is a considerable fall in the atmospheric humidity. With the break of the monsoon there is a drop in the air temperature, but there is at the same time a rapid rise in atmospheric humidity. Thus during summer months potatoes have to be protected against the effects of excessively high temperatures and low atmospheric humidity; whereas during the monsoon the tubers have to be protected against the effects of high humidity.

There is ordinarily a great amount of loss of tubers during summer months. The chief cause of this loss is "heat rot" or "black heart", a disease not due to any parasitic organism but is the result of the effects of high temparature. The diseased potato shows a black discolouration in the heart or the centre of the tuber, due to changes taking place in the local areas of the tuber brought about by the death of certain cells; this discolouration increases in area and the whole tuber may be ultimately involved. The affected parts are later reduced to a pulp and the tuber ultimately gives off an offensive odour, and drops of a dirty coloured liquid ooze out of the skin, particularly from the "eyes".

Other diseases that are commonly found to be destructive to tubers under storage conditions are rots, wet and dry, caused by *Fusarium* spp., *Rhizoctonia bataticola* and bacteria.

Several experiments have been conducted for evolving suitable methods of storage; for the storage there has been a two-fold object, one to preserve potatoes for use as

seed for *kharif* and *rabi* sowings and the second to store potatoes for the table use, during summer months.

The essential condition for the storage of potatoes is that each individual tuber must be sound in every way; it must be not only free from disease, but its skin must also be unbroken. Therefore potaoes were rigidly selected before they were used for storage. Any tuber that showed even the least sign of disease or had its skin broken, was rejected. These rejected tubers were quite good enough for immediate consumption. For the storage experiments potatoes were usually purchased from the local market; in very few cases were they the selected produce of a potato farm; tubers of all sizes were stored together, since the object was not only to find ways and means of storing seed potatoes but also potatoes for table use. Since the potatoes were bought from the bazaar, there was the danger of the tubers being infected by the potato moth, and therefore the tubers after they were selected were fumigated with petrol. A wad of cotton soaked in petrol was placed at the bottom of a bin which was then filled with tubers. This bin was closed with a tight fitting lid. The rim of the lid was sealed with moist mud to make the bin as much air-tight as possible. The tubers were left in the bin for 24 hours. Fumigation with petrol is not essential if the tubers are free from infection by the potato moth. For the fumigation three pints of petrol per 100 cubic feet were used.

The method of storage in rooms, whether the tubers are packed in gunny bags or are preserved in sand or ash or kept exposed on racks, has been repeatedly found to be uneconomic and unsuccessful. At the end of the experiments hardly a few sound tubers are available. The method which has been found to be the most successful, after several trials for the last four or five years, is described below. This method of storage during summer months—from the end of February to the beginning of June—has been successful not only in cool parts of this Province, like Betul and Chhindwara, but also in Nagpur, where for long periods during summer months the maximum day temperature is normally above 110°F. (Plate XXXIV, fig. 2.)

A pit, about 24 to 30 inches deep. is made in the ground where the tubers are to be stored. The pit may be circular, rectangular or of any shape; the floor area of the pit depends on the quantity to be stored, but the depth of the pit is of importance. It should not be so deep that the tubers at the bottom of the pit are crushed by the weight of those piled above; a depth of 24 to 30 inches has been found to be satisfactory, The floor of the pit and its sides are watered a day before the tubers are to be stored to lower the temperature. Just sufficient water should be used to make the sides and the floor feel slightly damp and cool to the touch the next

morning. If the pit feels too wet, the storing of tubers should be put off till it is sufficiently dry.

The storing should perferably be done in the course of the morning before the day temperature rises. The floor of the pit and the sides should be lined with dry leaves or sugarcane trash, both of which are easily available at the time of the year the storage has to be done ; they serve to insulate the tubers from the soil ; potatoes kept covered in pits are liable to "sweat", due to processes of transpiration and respiration ; the accumulated moisture brings about various rots ; to avoid "sweating", and to have free aeration in the pits, pieces of hollow bamboos with the septa at the nodes removed and having holes on the sides are used to serve as "chimneys" or ventilators (Plate XXXIII and Plate XXXIV, fig. 1). These bamboo pieces or chimneys are about four to five feet in length, long enough to stand beyond the topmost cover or roof of the pit. The nodal septa are easily broken by forcing an iron rod or a crowbar through the openings at the cut ends ; or the bamboo piece is split longitudinally into two and the septa then removed ; holes are bored or cut in the sides, one hole to each internode. It is preferable to have the holes made on different sides of the bamboo piece. If the bamboo is split into two, the two component parts are tied together, to keep them in position. These bamboo pieces or chimneys are placed vertically in the pit at a distance of three to four feet apart. The pits are then filled with the potatoes to be stored. The tubers are spread out in the open the night previous to their being stored, so that they may be as cool as possible at the time of storing. The pits are filled with tubers up to about 6 inches below the brim, and then covered with a thick layer, eight to twelve inches deep, of dry leaves or sugarcane trash (Plate XXXIII). These dry leaves or trash are kept in position and are prevented from being blown about by wind by placing over the pit a cover made of some thatching material, like dry grass or leaves, held together in a frame work of split bamboos or sticks. This cover is held in position by placing on its margins bricks or heavy stones to prevent it from being dislodged by small animals. The vent holes on the exposed parts of the chimneys or ventilators, which protrude beyond the roof of the pit, are covered in such a way, with wire gauze or pieces of old sacking or dry grass, that insects and rodents do not get entrance into the pits through these openings but at the same time fresh air is allowed to circulate in the pit through the covered holes. These pits are preferably made under a tope of trees (Plate XXXIII, fig. 1), or they should be protected by a temporary shed of some sort (Plate XXXIII, fig. 2) so as to keep off, as far as possible, direct rays of the sun and also to serve as a protection against sudden rain storms which are not uncommon in the latter part of summer.

Round the pits a trench, about six inches deep and four inches wide, is made. This trench serves as an irrigation channel. The storage pits are occasionally

Fig. 1.

Fig. 2.
Potato Storage Pits.

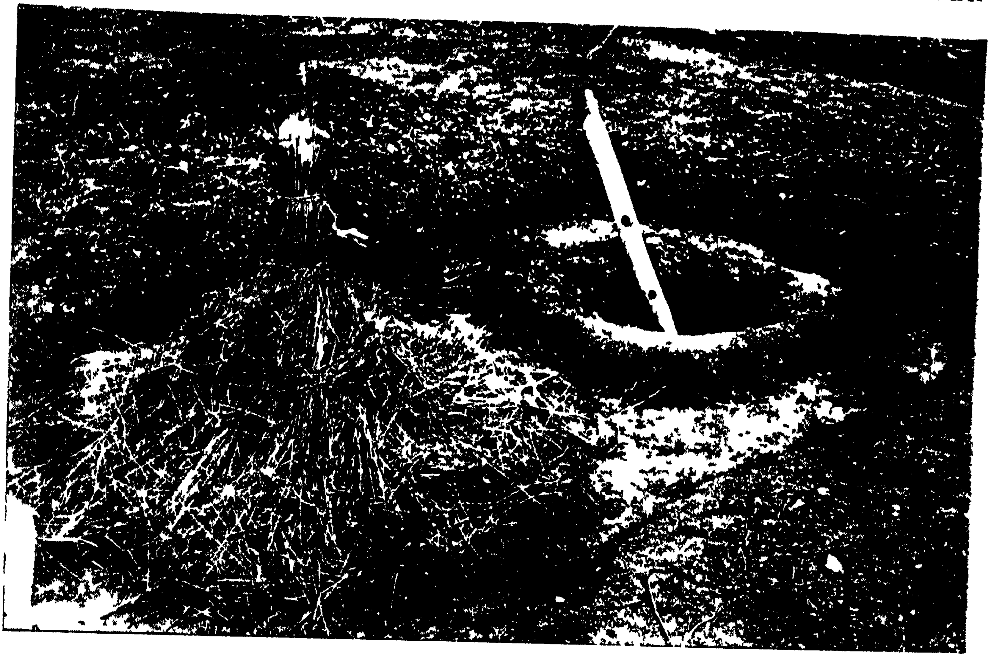

Fig 1 Two storage pits Note the bamboo "ventilator" in the empty pit on the right The one on the left shows close up" view of a pit filled with potatoes.

Fig 2 The total contents of a pit filled in February and opened in June. Note the proportion of diseased tubers—the heap on the right—to healthy tubers—the heap on the left

irrigated to reduce the temperature and to raise the humidity inside the pits. They are usually irrigated once a fortnight or once in three weeks, but the number of times the irrigation is done depends on the temperature and humidity of the air.

It is undesirable to store too large a quantity in a single pit. This is to avoid the possibility of the spread of disease. For the requirements of the potato dealer who has to take his stuff to the bazaar on bazaar days it is suggested that these pits may be of such a size that his requirements for each individual bazaar day may be met by the entire contents of one or more pits, so that the same pit may not have to be opened and closed over and over again.

The pits made one year can be used the following years and so also the bamboo chimneys or ventilators. Thus the cost of storing potatoes by this method is very little after the first year of storage.

The tubers when removed from the pits in the second week of June or before the break of monsoon show a certain amount of germination, especially those at the bottom of the pit. These tubers are healthy and can be utilised as seed for *kharif* sowing. This underground method of storage can be used only in the dry season. Before the rains set in the stored tubers must be removed from the pits.

The results of some of the storage experiments are given below (Table I):–

TABLE I.

| Details | Quantity stored in February lbs. | Quantity of sound potatoes recovered in June lbs. | Percentage of sound tubers |
|---|---|---|---|
| **Year 1926.** | | | |
| *Chhindwara. Stored in pits.* | | | |
| Fumigated, treated (pickled in mercuric chloride). | 304 | 267 | 87·8 |
| Fumigated, control . . . . | 174 | 128 | 73·5 |
| *Nagpur. Stored in pits.* | | | |
| Fumigated, unselected control . . | 40 | 11 | 27 5 |
| „ selected, treated (mercuric chloride). | 55 | 46 | 83·6 |

TABLE I—*contd.*

| Details | Quantity stored in February lbs. | Quantity of sound potatoes recovered in June lbs. | Percentage of sound tubers |
|---|---|---|---|
| **Year 1927.** | | | |
| *Chhindwara. Stored in pits.* | | | |
| Fumigated, treated (mercuric chloride) . . | 744 | 640 | 86 |
| „ „ (uspulun) . . | 480 | 398 | 83 |
| „ control . . . . . . | 334 | 311 | 93 |
| *Betul. Stored in pits.* | | | |
| Fumigated, treated (mercuric chloride) . | 388 | 367 | 94·5 |
| „ „ (uspulun) . . . | 380 | 356 | 93·6 |
| „ control . . . . . . | 351 | 335 | 94 |
| *Nagpur. Stored in pits.* | | | |
| Fumigated, treated (mercuric chloride) | 198 | 183 | 97·9 |
| „ „ (formalin) . . . | 185 | 158 | 85·4 |
| „ „ control . . . | 203 | 149 | 73·3 |
| **Year 1928.** | | | |
| *Chhindwara. Stored in pits.* | | | |
| Fumigated, treated (formalin) . . . | 1,080 | 845 | 78·4 |
| „ control . . . . . | 974 | 780 | 80·1 |
| Unfumigated, treated (formalin). . . | 506 | 457 | 90·3 |
| „ control . . . . . . | 493 | 429 | 87 |
| *Nagpur. Stored in pits.* | | | |
| Fumigated, treated (formalin) . . . | 151 | 122 | 80·7 |
| „ control . . . . . . | 158 | 130 | 82·2 |
| Unfumigated, treated (formalin) . . . | 144 | 117 | 81·2 |
| „ control . . . . . . | 106 | 85 | 80·1 |

TABLE I—*contd.*

| Details | Quantity stored in February lbs. | Quantity of sound potatoes recovered in June lbs. | Percentage of sound tubers |
|---|---|---|---|
| **Year 1929.** | | | |
| *Chhindwara. Stored in pits.* | | | |
| Selected, fumigated, steeped in formalin | 1,050 | 930 | 88·5 |
| „ „ formalin fumes | 1,126 | 914 | 81·1 |
| „ „ untreated | 1,784 | 1,400 | 78·5 |
| „ not fumigated, steeped in formalin | 662 | 546 | 82·7 |
| „ „ „ not treated | 652 | 396 | 60·7 |
| Not selected, not fumigated, not treated, control. | 440 | 320 | 72·7 |
| **Year 1930.** | | | |
| *Nagpur. Stored in pits.* | | | |
| Selected, not fumigated | 2,570 | 2,328 | 90·6 |

The tubers were treated with fungicides, like formalin, mercuric chloride and uspulun, before storing them in pits to see if the treated ones kept better as seed than the untreated ; but after several trials it was found that if the tubers to be stored were well selected, there was no need of pickling them, as these fungicides did not influence the keeping properties of the tubers.

The following treatments were tried :—

(1) Tubers were pickled for half an hour in a solution or formalin made up by mixing one pint of commercial formalin in 30 gallons of water.

(2) Instead of pickling tubers in a solution of formalin they were subjected for three hours to its vapours. A cloth soaked in a solution of formalin (one pint in 30 gallons of water) was spread on the floor and a layer of potatoes was heaped on it. Formalin solution was then lightly sprinkled on the layer and then another layer was piled on it, and this second layer was similarly sprinkled with the formalin solution. Layer after layer of tubers was thus piled up and

each layer was similarly treated. The whole heap was then kept covered for three hours with gunny sacking moistened with the formalin solution.

(3) Potatoes were pickled in a mercuric chloride solution, 4 oz. in 30 gallons of water, for 1½ hours.

(4) Uspulun solution, 2 oz. in 5 gallons of water or 0·25 per cent. strength, for 1½ hours was used for pickling the potatoes.

The treated tubers were well dried in shade before storing them in pits.

The variations found in the results of the last five years tabled above are due to the difference in the quality of tubers. As the potatoes for storage were chiefly purchased from local bazaars, the quality has not naturally been the same every year ; the proportion of healthy to diseased tubers has varied considerably from year to year. In some years potatoes have been obtained which were very clean and practically free from disease, whereas in other years the proportion of diseased tubers to healthy tubers has been very high. It is this difference in the quality of potatoes that accounts for the difference in the quality of the marketable tubers obtained from the storage pits.

Potatoes have been also stored in rooms during the summer months—the tubers being either kept exposed in single layers on racks, or on floors, or covered with sand or ash, or kept in gunny bags and in all cases the quantity of marketable tubers obtained at the end of the experiments has been very negligible, and so the results are not given in a tabulated form. These experiments, which serve as controls for the pit-storage experiments, have been done in Nagpur, Chhindwara and Betul.

Many attempts have been made to preserve, during the rains, potatoes to be used as seed for the *rabi* sowing. The humidity during monsoon months is sufficiently high for the dormant eyes to begin to sprout ; in places like Chhindwara, Betul and Nagpur, where experiments have been often tried, the loss of tubers as a result of sprouting is very heavy ; when preserved in sand or ash less than 20 per cent. good seed is available by the end of the rains. It has been evident that during the rains seed potatoes cannot be prevented from sprouting in places where the humidity is high ; therefore last year tubers stored in pits in Nagpur during the summer months were stored during the rains at Akola, which is during the rains drier than Nagpur, where a duplicate series of experiments was also tried.

The potatoes before being stored during the rains were treated with fungicides, like copper sulphate or mercuric chloride, to see if they have any influence in checking the sprouting of tubers.

The results obtained at Akola and Nagpur are given below (Table II). :—

TABLE II.

*Storage experiments from June to October, 1930.*

| Treatment | Exposed on racks | | | Stored in bags | | | Stored in sand | | | Stored in ashes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity stored in lb. | Total weight at the end of the experiment in lb. | Percentage of healthy tubers | Quantity stored in lb. | Total weight at the end of the experiment in lb. | Percentage of healthy tubers | Quantity stored in lb. | Total weight at the end of the experiment in lb. | Percentage of healthy tubers | Quantity stored in lb. | Total weight at the end of the experiment in lb. | Percentage of healthy tubers |
| *Akola Farm.* | | | | | | | | | | | | |
| Selected, untreated | 135 | 63 | 46·5 | 135 | 12 | 9·0 | 135 | 56 | 41·5 | 135 | 51 | 38·0 |
| Selected, treated with mercuric chloride. | 135 | 49 | 36·5 | 135 | 12 | 9·6 | 135 | 43 | 33 | 135 | 40 | 30·0 |
| Selected, treated with copper sulphate. | 135 | 31 | 23·0 | 135 | 3½ | 1·8 | 135 | 15 | 12 | 135 | 20 | 15·0 |
| *Nagpur.* | | | | | | | | | | | | |
| Selected, untreated, control. | 61 | 20 | 34·3 | 61 | 6 | 11·0 | 61 | 17 | 30·4 | 57 | 0 | 0·0 |
| Selected, treated with mercuric chloride. | 47 | 12 | 28·5 | 47 | 0 | 0·0 | 47 | 10 | 17·4 | 57 | 0 | 0·0 |
| Selected, treated with copper sulphate. | 57 | 5 | 9·9 | 57 | 4 | 6·5 | 57 | 5 | 11·9 | 57 | 0 | 0·0 |

These results show that during the monsoon months potatoes can be preserved as seed better in a less humid place, like Akola, than in a moist place, like Nagpur. But as Berar is not a potato-growing tract, the seed has to be transported for storage from, and retransported for sowing to, the potato-growing districts in the north of the Province ; the cost of this transport, both ways, has to be taken into account when considering the economic value of storing in the Province potatoes as seed for *rabi* sowing.

Our experiments have shown that in this Province during the summer months potatoes can be preserved underground at a very small cost and without any appreciable loss, both for the table use and as seed for *kharif* sowing ; but whether during the rains potatoes to be used as seed for *rabi* sowing can be economically stored is a problem for further investigation.

# FLAME-THROWERS IN LOCUST (*SCHISTOCERCA GREGARIA*, FORSK.) CONTROL.

BY

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## Introduction.

The flame-throwers were first introduced during the Great War as a weapon in human warfare, and when a locust outbreak occurred in Syria during 1916-1918, the Germans employed these machines to fight this pest [Bodkin, 1929]. After the war, Vayssiere [1919] employed army flame-throwers in his campaigns against *Dociostaurus maroccanus*, Thnb., in the South of France, in 1919, and on account of the large measure of success attained he very strongly advocated the use of these machines against locusts. During the same year Bazile [1919] employed flame guns against *Schistocerca tatarica*, auct.* in Algeria and confirmed Vayssiere's results. In the following year (1920) locusts were destroyed in Turkestan by directing jets of burning oil on them by means of special knapsack apparatus [1920]. In 1928, Bodkin [1929] in Palestine and Mistikawy [1930] in Egypt evolved their own special types of flame "adaptors" and, attaching them to containers of compressed air spraying machines, employed them against *Schistocerca gregaria*, Forsk. Uvarov [1928], summing up the position, says about the flame-thrower :—" The cost, however, is very great, and is more than six times that of using poisoned baits ; this fact alone is sufficient to regard the use of flame-throwers and burning generally as methods without any future."

In order to find out the utility of the flame-thrower as a weapon in locust warfare under local conditions, Bodkin's flame-throwers were given extensive trials in the Punjab during the locust season of April-May, 1930. With a view to determine the cost of working these machines detailed observations were made, in a number of cases, the quantity of fuel used was determined and the weight of hoppers and adults killed was ascertained. To test these machines under different topographical and agricultural conditions in the Punjab, the operations were carried out in the districts of Hoshiarpur,† Ambala (Rupar‡ sub-division) and

*Synonym of *Schistocerca gregaria*, Forsk.

†*Hoshiarpur.*—It is situated between 30° 59′ and 32° 5′ N and 75° 30′ and 76° 38′ E. It is a typically submontane tract. It possesses a rich flora and consequently is very well wooded. Its annual rainfall is 34″. Green hedges round fields is a feature of this locality.

‡*Rupar.*—It lies between 30° 45′ and 31° 13′ N. and 76° 19′ and 76° 44′ E. It is a submontane tract and is well wooded. Its annual rainfall is 28″.

Campbellpur.* A squad of seven men with a battery of ten flame-throwers was employed. At the time of the trials the hoppers were mostly in the fifth stage and in some localities the adults had actually emerged.

I take this opportunity to express my sincere thanks to Mr. M. Afzal Husain, Entomologist to Government, Punjab, Lyallpur, for his very valuable suggestions and guidance during the progress of these experimental trials. I must also express my thanks to the Deputy Director of Agriculture, Jullundur, Deputy Commissioners of Hoshiarpur and Campbellpur, and Sub-divisional Officer, Rupar, for their very kindly affording facilities and rendering necessary help during the progress of the experimental trials in their respective districts, and to Mr. T. A. Miller Brownlie, Agricultural Engineer to Government, Punjab, Lyallpur, for his help in getting the machines fitted up for this work.

DESCRIPTION OF THE FLAME-THROWER.

A flame-thrower is essentially a pneumatic knapsack sprayer fitted with a flame-projecting appliance. Its construction is explained in Fig. 1. The machines employed in the following experiments were— Four Oaks Pneumatic Knapsack Sprayers, " Weeford " pattern and " Kent " pattern. These machines are carried on the back of operators.

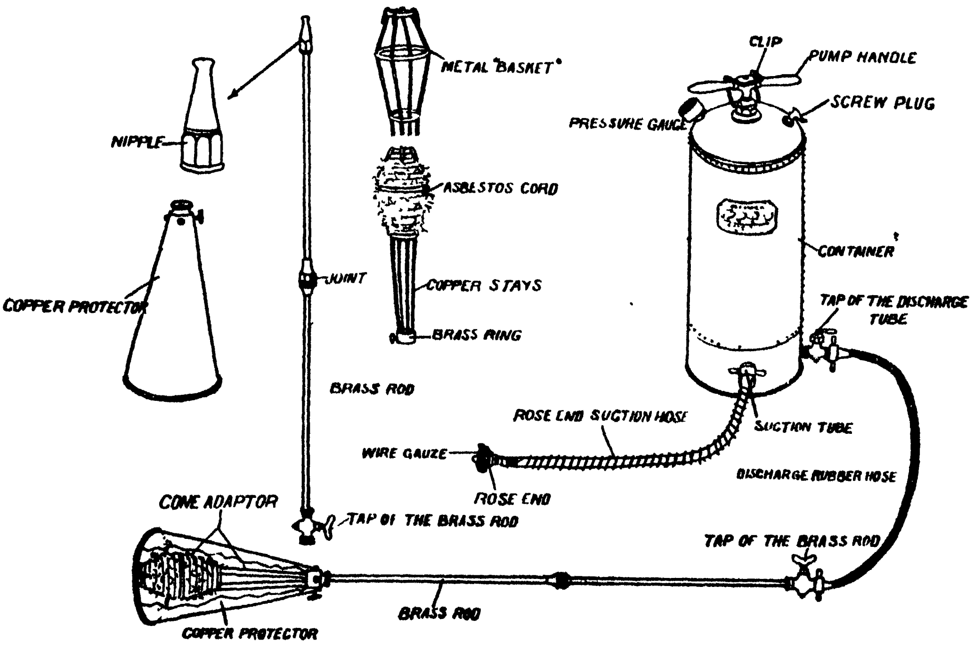


Fig. 1.

*Campbellpur.—It lies between 33° 46′ N. and 72° 22′ E. It is a hilly tract with a considerable area of level ground. Its flora is scanty, and annual rainfall is 17″-24″.

2 L 2

### METHOD OF CHARGING THE FLAME-THROWER.

In the "Weeford" pattern, before charging with the fuel the pressure in the machine is raised to 15 pounds per square inch. The rose-end suction hose is then screwed on to the intake or suction tube, and placed in the vessel containing the fuel. By working the pump, the requisite quantity of the fuel—about 2 gallons—is sucked into the container and simultaneously the pressure rises to 50 pounds per square inch. The suction hose is then disconnected and the machine is ready for use.

To charge the "Kent" pattern the screw cap of the charge hole is removed and the required amount of fuel—two gallons poured into the container and the cap tightly screwed on. The pressure of 50 pounds per square inch is then produced by means of the air-pump.

### PREPARATION OF THE 'ADAPTOR' FOR USE.

The copper protector is pushed back and the metal "basket" is so fixed in position that the top of the nipple comes to lie within the basal portion of the "basket". The asbestos cord is then soaked with fuel—the same fuel as is used in the machine—and ignited. The copper protector is pushed forward until it is in contact with the brass ring of the metal "basket" and tightened. The asbestos cord gets heated up in about a minute and the flame-thrower is ready for use. On opening the two taps the fuel is forced out under pressure, and passing through the lighted asbestos cord gets ignited and appears as a long tongue of flame.

The machine takes four minutes to charge and produces a flame 15 to 20 feet long and about 1 foot wide. A single charge—two gallons of fuel—burns continuously for 12 minutes.

### FUEL.

The fuel recommended by Bodkin [1929] is :—

| | |
|---|---|
| 1. Deisel oil | 2 parts. |
| 2. Petrol | 1 part. |

After a number of trials the following mixture was found to be the most suitable :—

| | |
|---|---|
| 1 Kerosine oil | 60 parts. |
| 2. Deisel oil | 30 ,, |
| 3. Petrol | 10 ,, |

This mixture is as efficient as the one recommended by the inventor and at the same time it is cheaper, for it costs Rs. 1-9-3 per single charge of two gallons as compared to Rs. 2-13-2 per single charge of Bodkin's mixture. It is suggested that the ready prepared mixture be carried in barrels to the field of operation. It avoids waste of precious time and carriage of too many separate receptacles.

Any cheap grade of kerosine oil, although slightly expensive, does equally well.

## EXPERIMENTS.

(1) On the 25th of April, 1930, two thick *keora* (*Agave* sp.) hedges, 330′ long×5′ wide and 49′ long×5′ wide, in Basi Mustafa, District Hoshiarpur, were treated. There was no vegetation near the two hedges, the land on both sides being fallow. Six machines were put to work and after two hours' continuous work 25 seers of fifth stage hoppers were destroyed. The kill was estimated at about 5 per cent. These hedges were very thick and the flame could not reach the hoppers that had dropped down to the base of the plants—hence the poor kill obtained. The fuel consumed was eight gallons. The cost of killing 25 seers of hoppers was Rs. 6-2, *i.e.*, Rs. 11-12-9 (including labour) per maund of hoppers killed.

(2) In the afternoon of the same day a thick swarm of hoppers was found resting on a few *mallah* (*Zizyphus nummularia*) shrubs and 16 mango (*Mangifera indica*) plants. Six machines were worked for two hours and killed 9 maunds and 15 seers of hoppers. The kill obtained was estimated at 95 per cent. Seven gallons of fuel was consumed. The cost of killing 9 maunds and 15 seers of hoppers came to Rs. 5-5-9, or As. 11-3 (including labour) per maund of hoppers killed.

(3) On the 26th of April, 1930, a *keora* (*Agave* sp.) hedge, 100′ long×4′ wide, was treated with a view to see whether it was not possible to burn the hoppers at the bases of these plants. The attempt failed, for only 5 per cent. kill was obtained. Two gallons of oil was consumed and 8 seers of hoppers were killed. The cost of killing 8 seers of hoppers come to Rs. 1-8-6, *i.e.*, Rs. 9-3-6 (including labour) per maund of hoppers killed.

(4) The same day hoppers resting on *basuti* (*Adhatoda vasica*), *mallahs* (*Zizyphus nummilaria*), and *sarkanda* (*Saccharum sara*), etc., growing on the banks of a water channel (450′ long×20′ wide) were treated. Five machines were put to work, 14 gallons of fuel was consumed, and 14 maunds and 23 seers of hoppers were killed. The kill obtained was 95 per cent. The cost of killing one maund of locusts works out to be As. 13-2 (including labour).

(5) On the 27th of April, 1930, a thick swarm of fifth stage hoppers and newly emerged adults was resting on 11 mango (*Mangifera indica*) trees, and 100 *mallah* (*Zizyphus nummilaria*) shrubs in Mal Mazara, District Hoshiarpur; four machines were put to work, and 11 maunds and 3 seers of hoppers were killed, representing 90 per cent slaughter.

(6) On the same day a *keora* (*Agave* sp.) hedge, 200′ long×5′ wide, was also treated and only 25 seers of locusts were destroyed. The kill obtained was estimated at 5 per cent. In the above experiments—11 maunds and 28 seers of locusts were killed and 22 gallons of oil was consumed. The cost of the operation came to Rs. 1-13-9 (including labour) per maund of locusts killed.

(7) On the 29th of April, 1930, a thick swarm was reported from Basi Muda Khan, District Hoshiarpur, and the following places were treated :—

(*a*) A grave yard, 295′ long×100′ wide. The ground was overgrown with *basuti* (*Adhatoda vasica*) and there were a few *shisham* (*Dalbergia sissoo*), *ber* (*Zizyphus jujuba*) and *sarin* (*Albizzia procera*) trees.

(*b*) A *chhittar thor* (*Opuntia multiflora*) hedge, 1,000′ long×13′ wide, with a few *sarkanda* (*Saccharum sara*), *keora* (*Agave* sp.) and *shisham* (*Dalbergia sissoo*) plants.

(*c*) A *phallia* (*Acacia modesta*) hedge, 500′ long×10′ wide, with a few *basuti* (*Adhatoda vasica*) and *danda thor* (*Euphorbia royleana*) plants.

(*d*) A *nara* (*Arundo donax*) hedge, 490′ long×5′ wide.

Six machines were put to work. The work was done between 7-40 A.M. to 0-45 P.M. and from 4-30 to 7-35 P.M., 84 gallons of fuel was consumed and 30 maunds of hoppers were killed. The kill obtained was estimated at 80 per cent. As *Opuntia* hedge and *sarkanda* were growing very thickly, it was not possible to kill the hoppers that had dropped among the bases of these plants.

The total cost of working, including labour, came to Rs. 2-5-7 per maund of hoppers killed.

(8) On the 30th of April, 1930, a very thick swarm of hoppers was met at Basi Nau, District Hoshiarpur. At this place a mango grove measuring 88′ long×50′ wide was treated. The ground underneath the trees was grown over with *basuti* plants. Five gallons of oil was consumed, and 2 maunds and 7 seers of hoppers were killed. The kill obtained was estimated at 95 per cent. The cost of killing one maund of hoppers works out at Rs. 3-8-6 (including labour).

(9) At Sataur, a *danda thor* (*Euphorbia royleana*) hedge, 197′ long×5′ wide, was treated. The three machines killed 28 seers of hoppers and consumed three gallons of oil. The kill obtained was estimated at 95 per cent. The cost of killing one maund of locust works out to Rs. 4-11-9 (including labour.)

(10) On the 3rd of May, 1930, six machines were put to work along the left bank of Sirhind Canal, Rupar. The soil was sandy and grown over with *sarkanda*. With other plants it formed a continuous strip of green vegetation about ½ mile long. The conditions were ideal for the use of the flame-throwers. The machines worked from 10 A.M. to 0 30 P.M., and from 4-30 to 7-30 P.M., and killed 21 maunds of hoppers and consumed 36 gallons of oil. The *sarkanda* bushes catch fire readily and therefore the kill obtained was cent per cent. The cost of killing one maund of locust in this case came to Rs. 1-13-4 (including labour). In this experiment a very costly fuel, Swan kerosine oil, only was available and it cost As. 14-1½ per gallon, instead of As. 12-3.

(11) On the 4th of May, 1930, six machines again worked along the banks of Sirhind Canal and treated hoppers resting on mango and *shisham* trees, etc. Dried *sarkanda* was spread underneath each tree prior to burning. The machines worked from 6 A.M. to 0-30 P.M., 15 maunds and 10 seers of hoppers were killed and 12 gallons of oil was consumed. The kill obtained was estimated at 95 per cent. The cost per maund of hoppers killed came to Rs. 1-2-2 (including labour).

(12) On the 9th May, 1930, the squad visited Mansar, District Campbellpur. Here the swarm was found resting on 55 mulberry plants, 23 *drek* plants, and a hedge, 30′ long×2′ wide. Dried straw was spread underneath mulberry (*Morus alba*) and *drek* (*Melia azedarach*) plants. Six machines worked from 6 to 11-30 A.M., and from 5-15 to 8 P.M., and burnt 40 maunds and 20 seers of hoppers, and 46 gallons of oil was consumed. The kill obtained was estimated at cent per cent. The cost per maund of hoppers killed came to As. 15-6 (including labour).

In the above, only those cases have been mentioned in which actual quantity of the fuel used and the weight of hoppers and adults destroyed were worked out. In so far as hopper destruction was concerned, very useful work was done, but in Applied Entomology the utility of a measure has to be determined in relation to cost. In what follows the difficulties encountered and the experiences gained have been outlined.

## COST OF WORKING THE FLAME-THROWER.

As would be evident from the above account and the statement given, the cost of working the flame-throwers is very variable, depending on the situation and the intensity of the swarm, and, inspite of Bodkins [1929] and Mistikawy's [1930] claims to the contrary, even under the most favourable circumstances it is very high [1920] as compared with trenching and baiting [Uvarov, 1928]. In case of rash and injudicious use of the flame-thrower the cost of destroying one maund of locust (No. 1 of the statement) may be as high as Rs. 11-12-9. On the other hand ,when used carefully and on the hopper swarm of right density in suitable conditions, the cost for killing one maund of hoppers drops down to As. 11-3 (No. 2 of the statement), and with swarms on trees when *sarkanda*, or any other dried material is combined with the flame-gun, the figure of As. 15-6 per maund is obtained (No. 12 of the statement). On an average the price of one maund of locust destroyed by means of the flame-thrower can be taken as Rs. 1-8-6 per maund of 4th and 5th stage hopper or locusts killed.

## WHERE AND HOW TO USE THE FLAME-THROWER ?

Experience has shown that a great deal of the success with the flame-throwers depends upon the judgment and the experience of the operator. One must be able to

*Statement showing the working*

| No. of experiment | Date | Locality | Labour employed | Time during which experiment was performed | Weight of hoppers killed | | Total quantity of fuel consumed |
|---|---|---|---|---|---|---|---|
| | | | | | Mds. | Srs. | Gallons |
| 1 | 25th April 1930. | Basi Mustafa (Distt. Hoshiarpur). | 5 daily paid men @ Re. 1 each. | 8-12 to 10-12 a.m. . | ... | 25 | 8 |
| 2 | 25th April 1930. | Basi Alli (Hoshiarpur.) | Ditto | 4-30 to 6-30 p.m. . | 9 | 15 | 7 |
| 3 | 26th April 1930. | Ditto . | Ditto . | 7-45 to 8-15 a.m. . | ... | 8 | 2 |
| 4 | ... | Ditto . | Ditto . | 8-15 to 10-0 a.m. . | 14 | 23 | 14 |
| 5 | 27th April 1930. | Mal Mazara (Hoshiarpur). | Ditto . | 8-35 to 11-30 a.m. . | 11 | 8 } | 22 |
| 6 | Do. . | Ditto . | Ditto . | 3-0 to 5-0 p.m . | | 25 } | |
| 7 | 29th April 1930. | Basi Muda Khan, (Hoshiarpur). | 6 daily paid men @ Re 1 each | 7-40 a m to 0-45 p m and 4-30 to 7-35 p m. | 30 | .. | 84 |
| 8 | 30th April 1930. | Basi Nau (Hoshiarpur) | 8 daily paid men. 7 @ Re 1 each and 1 @ As. 12. | 7-0 to 10-30 a m. . | 2 | 7 | 5 |
| 9 | 30th April 1930. | Sataur (Hoshiarpur). | Ditto | 10-35 to 11-45 a.m. | ... | 28 | 3 |
| 10 | 3rd May 1930 | Rupar (Ambala). | 9 men @ As. 12 each. | 10-0 a.m. to 0-30 p.m. and 4-0 to 7-30 p.m. | 21 | ... | 36 |
| 11 | 4th May 1930 | Rupar (Ambala). | Ditto . | 6-0 a.m to 0-30 p.m. | 15 | 10 | 12 |
| 12 | 9th May 1930 | Mansar, (Campbellpur). | 4 men @ Re. 1 each. | 6-0 to 11-30 a.m. and 5-15 to 8-0 p.m. | 40 | 20 | 46 |

*expenses of a flame-thrower.*

| Price of fuel per gallon | Total cost excluding labour | Estimated cost of killing one maund or 42,000 5th stage hoppers including labour | Area | Plants | Remarks |
|---|---|---|---|---|---|
| As. p. | Rs. as. p. | Rs. as. p. | | | |
| 12 3 | 6 2 0 | 11 12 9 | 330′ × 5′ and 49′ × 5′ | *Keora* hedges . . | Fifth stage hoppers and newly emerged adults. |
| 12 3 | 5 5 9 | 0 11 3 | | 16 mangoes and a few *mallah* shrubs | Ditto. |
| 12 3 | 1 8 6 | 9 3 6 | 100′ × 4′ | *Keora* hedge . | Ditto. |
| 12 3 | 10 11 6 | 0 13 2 | 450′ × 20′ | *Basutis mallah*, and *sarkanda shisham hirek* (*Diospyros montana* ?) (*carissa opaca*). | Ditto. |
| 12 3 | 16 13 6 | 1 13 9 | *Nil* | 11 mango trees, 100 scattered *mallah* plants of different sizes. | Ditto. |
| | .. | | 200′ × 5′ | *Keora* hedge . | Ditto |
| 12 3 | 64 5 0 | 2 5 7 | 295′ × 100′ 1000′ × 13′ 500′ × 10′ 490′ × 5′ | *Basuti* and a few *shisham*, *ber*, *sarin* trees, *chittar thor* hedge with a few *sarkanda*, *Keora* and *shisham* plants. A *phallia* hedge with *basuti* and *danda thor* a *nara* hedge. | Fourth and Fifth stage hoppers. |
| 12 3 | 3 13 3 | 3 4 10 | 88′ × 50′ | Mango grove with *basuti* growing underneath | Fifth stage hoppers and adults. |
| 12 3 | 2 4 9 | 4 11 9 | 197′ × 5′ | *Danda thor* hedge | Ditto. |
| 14 1½ | 31 12 6 | 1 13 4 | About ½ mile. | *Sarkanda* with a few scattered mango plants | Fifth stage hoppers |
| 14 1½ | 10 9 6 | 1 2 2 | *Nil* | Mango and *shisham* plants | Fifth stage hoppers. Here dried *sarkanda* was spread underneath treated plants. |
| 12 3 | 35 3 6 | 0 15 6 | 30′ × 2′ | A hedge, 55 mulberry plants, 23 *drek* plants. | Fifth stage hoppers Here dried straw was spread underneath treated plants. |

judge as to whether a particular band should be destroyed by burning or not. The work of the flame-gun is spectacular and impressive, but unfortunately it has also a demoralizing effect on the people inasmuch as it makes them magnify the presence of a mere "handful" of hoppers. This point is of enormous importance because it takes the operator to a wrong place and having gone to a place and being faced with the irresistable solicitations of the populace, he uses the flame-gun under unsuitable circumstances, with the result that the cost of the locusts killed soars to an alarming figure. It is, therefore, necessary that prior to the transport of the flame-thrower the reported swarm of hoppers must be visited by an experienced man. This visit will enable the operator to judge the suitability of action, and estimate the quantity of fuel that will be necessary to destroy the swarm. This point is very important because the cost of operation depends on this. Six machines consuming eight gallons of fuel may account for 25 seers of hoppers at the cost of Rs. 11-12-9 per maund of hoppers killed, or the same number of machines may be responsible for disposing of 9 maunds and 15 seers of hoppers by burning seven gallons of fuel working out at As. 11-3 per maund of hoppers burnt.

Burning hoppers can only be successful on plants which either catch fire, *e.g.*, dry bushes or allow the flame to penetrate into every part.

Burning hoppers among hedges of thick succulent plants such as *keora* (*Agave* sp.) should not be attempted (see experiments 1 and 3).

### METHODS OF BURNING UNDER DIFFERENT CONDITIONS.

*Hoppers in hedges, on bushes or shrubs.*—When dealing with a band in a hedge or on a bush or shrub, the two operators stand one on each side and first isolate an area by ringing it with fire, each producing his own half of the fire ring. The dry material present catches fire and brings down the insects. This fire aided by one or two flashes on the plants followed by two or three flashes at the bottom destroys all the locusts. It is not essential to burn to ashes, so to say, every flier or hopper because those that are singed and even those that try to escape from the burning base of the plant meet a speedy death.

*Hoppers on tall trees.*—A slightly different method is to be used in the case of the fliers or hoppers resting on tall trees. For this purpose two or three flame-throwers used together give the best results. During the operation the operators stand 30 feet apart round the tree and each operator by turn throws flashes up the tree and burns the hoppers that drop down. If a small quantity of *sarkanda* or dried straw is spread underneath the tree, then the band is burnt to the last hopper at a comparatively small cost (No. 12 of the statement), a hopper band was destroyed at a cost of As. 15-6 per maund (including labour).

In treating bands resting on mangoes, *Citrus* and *shisham* every care should be exercised not to burn the foliage. For this purpose quick flashes of fire should be thrown on the plants and the flame should not be kept playing for too long. This is quite enough to frighten the hoppers which drop down to the ground like hail and can then be burnt. It may be mentioned that if fire is lit under the trees or burning hoppers is attempted by torches or flame-throwers, the hoppers drop down literally like hail.

### THE TIME SUITABLE FOR WORKING THE FLAME-THROWER.

It has been found that the early morning (6 to 9 A.M.) and evening (5-30 to 7-30 P.M.) hours are the best for hopper destruction with the flame-thrower, because during this time the hoppers are found congregated on bushes, shrubs, trees and in hedges, and they are very sluggish and unwilling to move. At other times of the day they are very active and a slight disturbance makes them drop down to the ground from bushes and trees and scatter in all directions. Besides, when the day warms up, it is very uncomfortable to work with a flame-gun.

### CARE OF THE MACHINE.

When a day's work is done, fuel should be taken out of the container and soda solution or clean water pumped through the sprayer in order to flush out all the mineral oil; this will prevent the rubber and leather parts from deteriorating quickly. Soot from the asbestos cord should be carefully removed with a rag. The discharge rubber hose and the brass rod carrying the "adaptor" should be disconnected and the machine with its accessories should be carefully stored in a safe place. The brass rod carrying the "adaptor" should not lie on the ground, but should stand erect with the wide mouth of the copper protector touching the ground and the metal "basket" pushed back.

The plunger packing also requires periodical examination and renewal. Failure to attend to the plunger packing results in a strong and forcible jet of the fuel issuing out with the strokes of the plunger rod during the charging operation and bathing the eyes and face of the operator.

### THE DEFECTS OF THE MACHINE.

The container is very strong and there is little likelihood of its bursting even when the machine is working under full pressure during the hottest part of the day, but the machine has a few serious defects. The discharge rubber hose is the weakest part. The rubber lining is affected by fuel mineral oils and deteriorates very quickly with the result that small pieces of rubber come off and block the nipple. These chokes unfortunately have the "uncanny" knack of occurring during the thick of the operation, and a considerable time must elapse before the operator is able to set the machine in working order again. The

hot flame-producing part cannot be handled, and one must wait till it has cooled down. Washing the discharge-rubber-hose with water containing a little quantity of soda increases the life of the tube, but is not a sufficient guarantee for the proper working of the hose during any one operation. Flexible tubes made of galvanized iron are being tried and are likely to prove more lasting.

The nipple also gets choked up with sand, dirt, etc., which gets in mostly through the inlet tube at the time of charging with fuel. To keep the grit out of the machine it is absolutely necessary that the rose-end rubber hose should not be knocked about on the ground during and after charging, and that the suction tube should be properly capped after the charging is over. It is also necessary to have the fine mesh wire gauze on the rose-end to strain the fuel thoroughly.

To increase the efficiency of the machine it is necessary to make the nipple self-cleaning, as is the case with the "vermorel nozzle". This will enable the operator to relieve the choke the moment it occurs.

The diameter of the hole of the nipple should be narrowed down, because in the present nipple, due to the thickness of the issuing steam of fuel, only 40 per cent. of the fuel catches fire and the remaining 60 per cent escapes unburnt and thus gets wasted. In addition to the narrowing down of the hole, a strong pin should be suspended in front of the hole in such a manner as to spread out the stream of oil slightly. These improvements in the nipple will ensure the conversion of the stream into a flame without sacrificing its length. Besides, the spread out flame will cover a larger area at its termination and thus prove more useful.

The copper stays of the metal "basket" carrying the asbestos cord are another source of trouble. These become soft on account of the heat of the flame with the result that during the operation the "basket" bends and comes to lie right in front of the nipple. The free discharge of fuel is thus interfered with, and consequently a satisfactory flame is not produced. Besides, the flame being very near the operator, the heat produced is so great that it becomes positively uncomfortable for him to work the machine. These stays therefore should be made of some material like "tempaloy" (a copper alloy) which will stand the heat better.

The brass rod gets heated up during the operation with the result that it becomes very difficult for the operator to hold it. To get over this trouble the brass rod should be provided with a small adjustable wooden handle which will be set in position by the operator according to his needs.

In the copper protector no arrangement is made for the supply of oxygen to keep up the asbestos cord flame when the machine is not actually in use. A few holes at the bottom of the copper protector will remove this defect.

PRECAUTIONS.

1. Do not use a machine of the soundness of which you are not sure.
2. Do not allow any other operator to take fire from your burning asbestos cord ; it is dangerous.
3. Work with extreme caution in the vicinity of stacks and ripened crops of wheat and barley because a slight carelessness may set the entire area extending over many square miles on fire.
4. Do not allow spectators to stand too near ; there may be accidents.
5. Where several machines are working do not lift your flame in the air without being sure that no body is present on the opposite side.
6. Never take your eyes off the flame ; when not looking you may point it at an object with serious consequences.
7. Do not fail to boil your *dongries* in water at least twice a week so as to wash out the oil.
8. Do not use the machine when a strong wind is blowing.
9. Carefully examine all joints and washers before starting the work.

DRESS.

The usual field dress—shorts and shirt—is not suited for locust destruction with the flame-throwers. Hoppers when disturbed crawl on to the operator, get underneath his shorts and shirt, and produce an indescribable feeling of horror and disgust. Moreover, these hoppers are capable of inflicting uncomfortable bites. Besides, the exposed parts of the operator's body are very badly cut by the jagged leaves of *Sarkanda* (*Saccharum sara*) and thorns of *mallahs* (*Zizyphus numilaria*) and *phallias* (*Acacia modesta*). Further, the dress is spoiled by the fuel and holes are burnt in it. Finding the inadequacy of the above dress, *dongri* made of thick Khaki drill with buckle arrangement at the ends of sleeves and legs for tightening up was used and gave excellent service. The price of a *dongri* is about Rs. 7-0.

To protect eyes, particularly against the shooting sparks, ordinary goggles with coloured glasses do quite well.

LABOUR.

The flame-thrower is not entirely 'fool proof' and is liable to get out of order fairly frequently. The disorders developed may be slight, but their detection and consequent correction depends upon a thorough knowledge of the working of the various parts of the machine. It is therefore necessary to train the workers before a campaign is undertaken. Moreover such a training is necessary to save fuel, because on the actual duration of "flame projection" depends the efficacy of the measure and the cost of operation. By employing trained people accidents can also be avoided.

## LIMITATIONS OF THE FLAME-THROWER.

The flame-thrower is indeed a very efficient appliance for speedily destroying hoppers or fliers clustered in dense masses, but unfortunately it has very limited application. It cannot be used on windy and rainy days. It is not so effective on actively marching bands of hoppers and is uneconomical against small and thin locust swarms. Besides, for obvious reasons, the flame-thrower cannot be used to destroy hoppers and fliers taking shelter in crops and is ineffective in thick green hedges of xerophytic plants such as *Opuntia* and *Agave.*

Good results may be obtained by driving hoppers to some sort of low growing vegetation like *basutis* (*Adhatoda vasica*), *mallahs* (*Zizyphus numilaria*), etc., growing on a level piece of ground and then burning them; but in such cases they could be dealt with more economically by baiting, or trenching.

## THE PLACE OF FLAME-THROWERS IN LOCUST CONTROL OPERATIONS.

The flame-thrower is used to the best advantage on benumbed, copulating, egg-laying, and newly emerged adults, as well as on hoppers of all stages congregated in very thick and dense swarms on low-growing bushes like *basuti* (*Adhatoda vasica*), *mallahs* (*Zizyphus numilaria*), *phallias* (*Acacia modesta*), *bhang* (*Cannabis sativa*), hedge row plants and on small-sized plants of *kiker* (*Acacia arabica*), and *ber* (*Zizyphus jujuba*) growing on level pieces of ground, as well as on tall plants. The initial cost and cost of working these guns being high (as is evident from the experiments carried out). they cannot be employed as a sole means of locust control. They can, however, be recommended as an important subsidiary method of control in locust warfare. The hoppers in low-growing bushes, thin hedges and trees, particularly road-side trees which otherwise remain untreated, can be effectively dealt with by means of the flame-throwers. For this purpose a squad of five men armed with a battery of five flame-throwers and the requisite amount of fuel touring in an affected locality in a motor conveyance will clear large tracts in a short time.

## CONCLUSION.

In short, flame-throwers are unsatisfactory as the chief means of dealing with the locust problem but serve a very useful purpose as a subsidiary method in locust control.

## SUMMARY.

Bodkin's flame-throwers were tried in the Punjab during April-May, 1930.

The fuel employed was :—

| | |
|---|---|
| Kerosene oil . . . . | 60 parts. |
| Deisel oil . . . . | 30 „ |
| Petrol . . . . . | 10 „ |

The experiments conducted proved that the destruction of hoppers resting among thick green hedges like *Agave* and *Euphorbia* cannot be properly and economically carried out by means of the flame-throwers. Thick hopper bands resting on shrubs and bushes which either easily catch fire or allow the flame to penetrate into every part or on medium-sized trees can be effectively controlled by this method.

Cost of working the flame-thrower varies and depends upon the experience and efficiency of the operator, density of bands, and situations where they are found. In case of injudicious use of the machine the price per maund of locusts killed (including labour) may be as high as Rs. 11-12-9; and in the case of the correct use it drops down to As. 11-3.

To burn hoppers on valuable trees like mangoes, citrus, and *shisham*, hoppers should be frightened with quick flashes and burnt on the ground.

Times suitable for working the flame-thrower are 6 to 9 A.M. and 5-30 to 7-30 P.M.

Every care should be exercised in the use of the machine, particularly in the month of April. During this month the wheat crop is mature and in most places, as far as the eye can see, one finds continuous stretches of the golden crop; a slight carelessness and many square miles of wheat fields would be reduced to ashes.

Though limited in its application, the flame-thrower would be an excellent appliance for speedily destroying benumbed, copulating, egg-laying and newly emerged adults, as well as hoppers of all stages congregated in very thick and dense bands on low-growing bushes like *basuti* (*Adhatoda vasica*), *mallahs* (*Zizyphus numilaria*), *phallias* (*Acacia modesta*), *sarkanda* (*Saccharum sara*), *Nara* (*Arundo donax*), *bhang* (*Cannabis sativa*), *garna* (*Carisa opaca*); small sized plants of *kiker* (*Acacia arabica*), and *ber* (*Zizyphus jujuba*); and on road-side trees.

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# THE EFFECTIVENESS OF DUST FUNGICIDES IN CONTROLLING GRAIN SMUT OF SORGHUM.*

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## INTRODUCTION.

Sorghum is a crop of very great importance in the Bombay Presidency, and is extensively cultivated in areas which receive an average rainfall of twenty-five to forty inches. It covers an area of over nine million acres, and is mainly grown as a grain crop, although its stalks are also used as fodder for the cattle. The most destructive disease of this crop is the grain smut caused by *Sphacelotheca sorghi* (Lk.) Cl. Kulkarni [1918] estimates the total money value of the annual loss due to sorghum smuts in the Bombay Presidency, at Rs. 2,02,55,365 (£1,350,357), a greater part of which he ascribes to the grain smut.

Until recently liquid copper sulphate was the standard fungicide in the Bombay Presidency for controlling the grain smut of sorghum (*jowar*). The treatment was effective and did not cause injury to the seed. Its chief limitations, however, were that it was cumbersome and wetted the seed, which necessitated drying before it could be sown. In fact, in 1926, it was pointed out by Mr. T. F. Main, now Director of Agriculture Bombay Presidency, that "copper sulphate propaganda in areas lightly affected by smut tends to defeat its own ends by being irksome to cultivators", with the result that they will sow smutted seed rather than steep it in copper sulphate. It therefore seemed desirable to use some of the dust fungicides and determine their effect on the amount of smut produced, and on the germination of seed.

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The foundation of the dust treatments was well laid by the work of Darnell-Smith [1915, 1917], and the later studies of Mackie and Briggs [1923] resulted in the extensive use of copper carbonate dust in the control of bunt of wheat. The popularity of copper carbonate led commercial organisations to develop and study numerous fungicides for the control of seed-borne diseases. In spite of the wide-spread interest in devising suitable dust treatments, there has not yet been developed a disinfectant which will be effective against seed-borne diseases and at the same time will be harmless to the cattle. The ideal is very difficult to attain ; but the conditions prevailing in the Bombay Presidency suggested that there was a striking need for such a treatment. It was therefore decided to test the value of sulphur dust for the disinfection of smutted sorghum seed, as it was realised that sulphur, when fed in small quantities with sulphur-dusted seed, was not likely to produce ill effects in the cattle. Copper carbonate and copper sulphate dusts, though strong poisons, were included in these tests to ascertain their effect on the control of smut.

This paper presents the results of experiments made during the past four years on the effectiveness and limitations of the three dust fungicides.

## Methods and Materials

The seed used was of Nilva, a variety of fodder *jowar* (sorghum) which is considered to be very susceptible to grain smut. The original smut inoculum was obtained from smutted heads of Nilva grown on the College Farm, Poona, and in each year sufficient inoculum was collected from the experimental plots for use in the following year. The seed was artificially infected by placing 25 grams of sorghum in 500 c.c. Erlenmeyer flasks and adding the desired quantity of inoculum (smut spores) to each flask. The flasks were shaken for a sufficient length of time to coat the seed thoroughly with the inoculum. The spore load ranged from 1-250 to 1-3,000, *viz.*, from 1 part of inoculum to 250 parts of seed to 1 to 3,000 parts. With the heaviest spore load (1-250), the seed was practically blackened and was very much smuttier than the seed with the heaviest natural infection The lightest spore load (1-3,000) gave a few hundred spores per seed, which were barely visible to the naked eye. The heaviest spore loads were used to ascertain the limits of efficiency of the dust fungicides.

The fungicides used in these experiments were in the dust or powder form. The following is a list of the dusts, together with the names of their manufacturers :

| | |
|---|---|
| Copper carbonate (containing 53 per cent. copper) . | Geo. Monro, Ltd., London. |
| Copper sulphate No. 1 (coarse powder) . . | British Sulphate of Copper Association, Ltd., London. |
| Copper sulphate No. 2 (same as No. 1 above, but passed through a 200-mesh sieve) . . . | Ditto. |

| | |
|---|---|
| **Kolodust** . . . . . . . . . | **Niagara Sprayer Company, Middleport, N. Y., U. S. A.** |
| **Sulphur-A (passed through a 100-mesh sieve)** . | **Dharamsi Morarji Chemical Company, Bombay, India.** |
| **"Fungus" sulphur (200-mesh fine)** . . . | **Ditto.** |

The disinfection of seed was carried out by adding an appropriate quantity of a dust fungicide to an Erlenmeyer flask containing artificially infected seed. The flasks were vigorously shaken so as to coat thoroughly every seed with the dust. They were then plugged with cotton and kept away until required for sowing.

The treated seed was sown by hand in unit plots of two 50-foot rows, which were separated by a space of one foot. The seed was sown at a distance of six inches, thus giving a theoretical number of 100 plants per row. The sowings were duplicated in each case. In all cases untreated, infected checks were sown for purpose of comparison.

Two seeds were sown in one place. After their emergence the seedlings were counted and the percentage of emergence calculated from these figures. The data on emergence are based on duplicate plots of 400 seeds each. After the emergence records were taken, one seedling was left in each place, the other being uprooted.

At harvest a total head count was made for each two rows and the percentage of smut determined. Partially affected heads were classified as smutted. The head-count method of estimating percentage of smut is preferable to counting of the total number of plants, in which case affected plants may have both healthy and smutted heads.

## Relation of spore load to smut infection.

It has been shown by Heald [1921] and Mackie and Briggs [1923] that the percentage of bunt in a wheat crop is directly proportional to the amount of infection carried on the seed sown. Since grain smut infection varies greatly from field to field in the same year, it was thought that a similar relation might hold good in this case. Experiments were therefore made to determine the relation between the dosage of smut spores on seed and the amount of infection.

Eight lots of seed were inoculated with smut spores. The proportion of spores to seed by weight ranged from 1-250 to 1-3,000, *viz.*, from 1 part of spores to 250 parts of seed to 1 to 3,000 parts. In 1930 a portion of the infected seed was sown with a country drill in order to compare the smut infection with that in the seed sown by hand. Wherever possible, check rows of non-inoculated seed were sown to obtain data on the emergence of seedlings. The results are summarised in Table I.

TABLE I.

*Summary of data on the relation of dosage of spores to grain smut infection, College Farm, Poona.*

| Year | Per cent. germination in field | Per cent. of smut by head count | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Proportion of spores to seed | | | | | | | |
| | | 1-250 | 1-500 | 1-750 | 1-1,000 | 1-1,500 | 1-2,000 | 1-2,500 | 1-3,000 |
| 1927— | | | | | | | | | |
| Experiment 1 . . . . | — | 9·3 | 18·9 | 5·3 | 6·1 | 5·5 | 8·2 | 2·6 | 4·1 |
| Experiment 2 . . . . | — | 10·6 | 7·3 | — | 4·1 | 13·3 | 6·7 | 5·3 | 1·6 |
| 1929— | | | | | | | | | |
| Experiment 1 . . . . | 78·3 | 26·3 | 16·2 | 12·4 | 13·9 | 11·6 | 2·2 | 0·7 | 0·7 |
| Experiment 2 . . . . | 77·5 | 16·2 | 8·1 | 4·1 | 6·5 | 4·0 | 4·9 | 0·7 | 0·7 |
| 1930— | | | | | | | | | |
| Experiment 1 . . . . | 68·8 | 15·9 | 13·2 | 8·1 | 0·0 | 6·2 | 2·6 | 9·3 | 5·3 |
| Experiment 2 . . . . | 68·5 | 8·7 | 10·4 | 14·7 | 9·3 | 11·8 | 12·0 | 12·2 | 15·6 |
| Experiment 3 . . . . | 66·7 | 22·1 | 14·0 | 14·9 | 10·5 | 8·9 | 17·1 | 18·1 | 19·3 |
| *Experiment 4 . . . . | — | 19·3 | 25·3 | 16 9 | 15·6 | 10·2 | 13·5 | 19·7 | 26·7 |
| *Experiment 5 . . . . | — | 25·2 | 22·9 | 20·6 | 21·7 | 16·9 | 17·7 | 16·9 | 27·4 |

* The seed was sown with a country drill and not by hand.

The results of these experiments, as given in Table I, indicate a general tendency for the smut infection to decrease with a reduction in spore load. They also show that the method of sowing seed does not affect the percentage of smut in different spore dosages. It is, therefore, evident that the amount of infection on the seed will influence the effectiveness of a fungicide and, in order to get a better indication of the limits of its efficiency, eight rates of inoculation were used.

In these experiments it was observed that it was not always possible to predict the percentage of smut in a crop by determining the amount of infection on the seed sown. It is probably due to the physical condition of the soil in which the seed is lodged, since, in our experiments on the conditions governing smut infection in sorghum, there is an indication that soil moisture exerts a far greater influence on infection than soil temperature. It is proposed to revert to this subject in a separate publication.

## EXPERIMENTS IN 1927.

In 1927 preliminary trials were made on the College Farm, Poona, to test the value of dust fungicides in the control of grain smut. The following five dusts were

investigated: (1) copper carbonate, (2) Sulphur-A, (3) "Fungus" sulphur, (4) copper sulphate No. 1, and (4) copper sulphate No. 2. They were applied at the rate of 1 to 4 ounces per 60 lbs. of seed. For each set of experiments checks were sown with untreated, infected seed. The effects of the various dusts on the control of grain smut are recorded in Table II.

TABLE II.

*Effect of certain seed disinfectants on the control of grain smut, College Farm, Poona, 1927.*

| Treatment | | Per cent. of smut by head count | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Proportion of spores to seed | | | | | | | |
| Dusts | Oz. per 60 lbs. | 1-250 | 1-500 | 1-750 | 1-1,000 | 1-1,500 | 1-2,000 | 1-2,500 | 1-3,000 |
| Copper carbonate | 1 | 0·0 | 2·8 | 1·3 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| | 2 | 0·7 | 0·0 | 0·0 | 0·0 | 1·3 | 0·0 | 0·0 | 0·0 |
| | 3 | 1·4 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| | 4 | 5·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | .. |
| Check (untreated) | .. | 28·5 | 34·1 | 23·0 | 27·6 | 22·6 | 23·8 | 25·0 | 18·1 |
| Copper sulphate No. 1 | 1 | 10·0 | 11·7 | 19·2 | 11·1 | 20·0 | 15·6 | 8·3 | 8·0 |
| | 2 | 13·8 | 11·9 | 8·6 | 16·0 | 3·7 | 2·5 | 19 1 | 4·0 |
| | 3 | 14·7 | 9·8 | 0·0 | 15·5 | 4·3 | 2 4 | 15·9 | 1·7 |
| | 4 | 18·1 | 16·9 | 5·5 | 8·4 | 7·1 | 2 6 | 0·0 | 2·1 |
| Check (untreated) | .. | 20·0 | .. | 18 7 | 28·5 | 26·0 | 31·0 | 25·0 | 3·3 |
| Copper sulphate No. 2 | 1 | 3·0 | 1·0 | 0·0 | 10·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| | 2 | 4·2 | 0·0 | 2·0 | 0·0 | .. | 0·0 | 0·0 | 0·0 |
| | 3 | 0·8 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | .. | 1·3 |
| | 4 | 1·9 | 0·0 | 0·9 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| Check (untreated) | .. | 9·3 | 2·9 | 7·4 | 2·0 | 0·0 | 1·8 | 11·4 | 5·1 |
| Sulphur-A | 1 | 16·5 | 27·1 | 18·2 | 3·3 | 13·5 | 5·3 | 3·6 | 1·7 |
| | 2 | 19·3 | 9·2 | 6·3 | 16·1 | 15·2 | 11·6 | 5·6 | 3·2 |
| | 3 | 0·0 | 17·5 | 1·0 | 1·9 | 0·8 | 0·0 | .. | 0·8 |
| | 4 | 10·8 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| Check (untreated) | .. | 13·8 | 13·3 | 14·5 | 15·8 | 14·3 | 2·4 | 27·5 | 3·8 |
| "Fungus" sulphur | 1 | .. | 0·0 | ·7 | 0·0 | 3·2 | .. | 0·0 | 1·3 |
| | 2 | 0·0 | 0·7 | 4·1 | 0·0 | 0·0 | 0·0 | 0·0 | 1·7 |
| | 3 | 0·7 | 0·0 | 0·7 | 0·0 | 1·7 | 0·0 | 0·0 | 1·0 |
| | 4 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| Check (untreated) | .. | 15·2 | 18·7 | 8·9 | 7·6 | 10·5 | 5·0 | 7·6 | 6·8 |

*Copper carbonate.*—Copper carbonate was the most effective in controlling smut. Two to four ounces of the dust per 60 lbs. of seed controlled infection for all spore loads except the heaviest (1-250). Even one ounce of the dust was effective for dosages of 1-1,000 or less; in heavier spore loads there was slight infection, the maximum being 2·8 per cent. in 1-500 spore load. For the spore loads of 1-750 or less, which represent the amount of natural infection on the seed, there was, therefore, no gain in smut control by increasing the dose of copper carbonate beyond two ounces per 60 lbs. of seed.

*Copper sulphate.*—For all the dosages of spores used in these experiments, copper sulphate No. 1 failed to prevent infection even when applied at the rate of 4 ounces per 60 lbs. of seed. This was probably due to the coarse powder which did not adhere properly to the grains. There was, however, no evidence of seed injury.

Copper sulphate No. 2 was a fine powder, and was very promising in control. Two to four ounces of this dust were practically fully effective, except for the heaviest dosage of spores (1-250), which gave a maximum infection of 4·2 per cent. One ounce of this dust was also effective for spore loads of 1-1,500 or less. It is, therefore, evident that, like copper carbonate, the two-ounce treatment gave the most effective results.

**Sulphur.*—Sulphur applied at the rate of four ounces per 60 lbs. of seed was fully effective, except for the heaviest dosage of smut spores (1-250). Three ounces of "Fungus" sulphur practically controlled infection for all spore dosages. Sulphur-A applied at this rate was somewhat less effective. This dust also failed to control smut at the rate of one or two ounces, but a satisfactory control was obtained with "Fungus" sulphur at the rate of two ounces for all spore loads except 1-750. It is evident from these results that, besides giving a better distribution of the dust on the seed, a fine grade of sulphur was superior to a coarse material in preventing smut infection, and was about as effective as copper carbonate dust.

The results on the control of smut obtained with the three dust fungicides were so encouraging that it was decided to continue them in 1928.

## Experiments in 1928.

In 1928 tests were made on the College Farm, Poona, and in the district. At Poona experiments were made with "Kolodust", "Fungus" sulphur, dehydrated copper sulphate and copper carbonate; but unfortunately very little smut developed in the treated as well as check plots, so the experiments were worthless from the standpoint of determining smut control. The data of experiments on the College Farm, Poona, are not included here.

* The writers take this opportunity to call attention to an error in the paper entitled "A preliminary report on experiments in the control of grain smut of jowar (*Andropogon sorghum*)" published in *Agr. Jour. India*, **23**, 471-472. Sulphur No. 1 should read as Sulphur No. 2, and *vice versâ*.

*District trials.*—The results obtained during the last year indicated that sulphur dust was as effective in controlling smut as copper carbonate dust. Arrangements were therefore made with the Divisional Deputy Directors of Agriculture to undertake extensive trials with a view to testing the merits of sulphur dust under field

TABLE III.

*Effect of sulphur dust on the control of grain smut in district trials in the Bombay Presidency in 1928.*

| Place | Per cent. of smut by head count | | |
|---|---|---|---|
| | 4-5 oz. per 60 lbs. | Check | |
| | | Untreated | Steeped in liquid copper sulphate |
| **South Central Division—** | | | |
| *Mohol Farm | 0·2 | 33·5 | |
| *Mohol Farm | 0·07 | 33·5 | |
| *Mahagaon | 0·0 | 50·0 | |
| Malsiras | 1·1 | 5·0 | |
| Do. | 0·0 | 2·0 | |
| Do. | 1·0 | 4·0 | |
| Gurshala | 0·0 | 9·0 | |
| Purandharwada | 0·0 | 3·0 | |
| Gurshala | 3·0 | 8·0 | 2·0 |
| Kurunde | 2·0 | 6·0 | 1·0 |
| **Southern Division—** | | | |
| Gadag | 0·0 | 1·0 | |
| Harti | 0·0 | 0·0 | |
| Mundargi | 1·5 | 7·4 | |
| Mallapur | 0·0 | 3·8 | |
| Kamalapur | 0·0 | 3·2 | |

* The seed was artificially infected with a spore dosage of 1-750. In all other cases, naturally infected seed was used.

TABLE III—*contd.*

*Effect of sulphur dust on the control of grain smut in district trials in the Bombay Presidency in 1928*—contd.

| Place | Per cent. of smut by head count | | |
|---|---|---|---|
| | 4-5 oz. per 60 lbs. | Check | |
| | | Untreated | Steeped in liquid copper sulphate |
| Southern Division— | | | |
| Hosayellapur | 0·0 | 3·2 | |
| Marewad | 0·0 | 0·0 | |
| Haveri | 0·0 | 0·0 | |
| Mudebihal | 0 0 | 8·0 | |
| Bijapur | 0·0 | 1·0 | |
| Do. | 0·0 | 4·0 | |
| Do | 0 0 | 3·0 | |
| Bendigiri | 0·0 | 0·0 | |
| Ankalgi | 0·0 | 0·0 | |
| Bailhongal | 0·0 | 0·0 | |

conditions. Local varieties of sorghum were treated at each place, and the plots varied in size from half an acre to one acre. Except in a few cases when artificially infected seed was used, naturally infected seed was treated with "Fungus" sulphur at the rate of 4 to 5 ounces to 60 lbs. of seed. At each place an untreated check plot was sown; but in some places check plots were also sown with the seed steeped in copper sulphate. The results are summarised in Table III.

In the South Central Division, plots were sown with the artificially infected (1-750 spore load) seed on the Mohol Farm and at Mahegaon. The smut was effectively controlled when 4 to 5 ounces of sulphur dust were used, and the check plots gave as high as 33 to 50 per cent. infection. As indicated in Table III, sulphur was quite effective in all other places except at Purandharwada, Gurshala, Dharam-

puri and Kurunde, although the percentage of infection was rather low. In the four places where sulphur dust failed to control smut effectively, copper sulphate steeping also gave unsatisfactory results. These results were surprising, and it is doubtful whether the treatment of infected seed was properly done.

The results of the trials on smut control made in the Southern Division were very satisfactory although the checks did not show much infection. It was also reported that sulphur dust gave better germination under field conditions than the untreated seed.

### EXPERIMENTS IN 1929.

Experiments on the College Farm, Poona, were continued in 1929, and only three dusts were used, namely "Fungus" sulphur, copper sulphate No. 2 and copper carbonate. Dehydrated copper sulphate dust was not included in these tests, as it caused injury to seed in the previous year. The results of these trials are recorded in Table IV.

### TABLE IV.

*Effect of certain seed disinfectants on the control of grain smut and on the germination of Nilva sorghum, College Farm, Poona, 1929.*

| Treatment | | Per cent. germination in field | Per cent. of smut by head count | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Proportion of spores to seed | | | | | | | |
| Dusts. | Oz. per 60 lbs. | | 1-250 | 1-500 | 1-750 | 1-1,000 | 1-1,500 | 1-2,000 | 1-2,500 | 1-3,000 |
| "Fungus" sulphur . . | 3 | 75·3 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| | 4 | 73·6 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| | 5 | 71·5 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| | 6 | 68·8 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| Check (untreated) . . | .. | 72·8 | 14·5 | 5·2 | 2·8 | 1·6 | 2·4 | 2·9 | 0·6 | 0·0 |
| Copper sulphate No. 2 . | 1 | 69·3 | 0·0 | 0·8 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 |
| | 2 | 73·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·7 | 0·0 |
| | 3 | 70·4 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0 0 | 0·0 |
| Check (untreated) . . | .. | 63·9 | 24·5 | 10·2 | 12·6 | 7·9 | 8·9 | 2·2 | 0·0 | 4·0 |
| Copper carbonate . . | 1 | 54·5 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·9 | 0·0 |
| Check (untreated) . . | .. | 54·3 | 28·0 | 14·6 | 11·9 | 1·0 | 7·0 | 2·2 | 1·0 | 3·1 |

TABLE V.

*Effect of sulphur dust on the control of grain smut in district trials in the Bombay Presidency in 1929.*

| Place | Per cent. of smut by head count | | |
|---|---|---|---|
| | 5 oz. per 60 lbs. | Check | |
| | | Untreated | Steeped in copper sulphate |
| SOUTH CENTRAL DIVISION— | | | |
| *Mohal Farm | 0·0 | 2·0 | 0·0 |
| *Malsiras | 2·0 | 8·0 | 0·0 |
| *Gurshala | 0·0 | 11·0 | 0·0 |
| *Dharampuri | 0·0 | 10·0 | 1·0 |
| *Yelavi | 0·0 | 5·7 | 0·0 |
| *Biswe | 0·0 | 3·0 | 0·0 |
| *Ankali | 0·0 | 1·0 | 0·0 |
| *Satara | 0·0 | 0·4 | 0·0 |
| *Vadhe | 0·0 | 2·0 | 0·0 |
| GUJARAT DIVISION— | | | |
| *Panchmahals District—* | | | |
| Rustumpura | 0·0 | — | |
| Halol | 0·0 | — | |
| *Broach District—* | | | |
| Nabipur | 0·0 | — | |
| Samni | 0·2 | — | |
| Nahir | 1·0 | 12·0 | |
| Amod | 0·5 | 5·5 | |
| Magnad | 0·3 | 1·9 | |
| Tundaj | 0·1 | 3·2 | |
| Vichhiad | 0·0 | 4·5 | |
| Akot | 0·0 | 4·5 | |
| Vagra | 0·0 | 3·3 | |
| Nanetha | 0·0 | 1·0 | |

* The seed was artificially infected with a spore dosage of 1-750. In all other cases, naturally infected seed was used.

"Fungus" sulphur, applied at the rate of 3 to 6 ounces to 60 lbs. of seed, gave perfect control for all spore loads. The results for 3 and 4 ounces are in general agreement with those in 1927. The dust caused no seed injury when compared with the untreated checks.

One to three ounces of copper sulphate No. 2 controlled smut in almost all spore loads, and had a beneficial effect on the germination of seed. In each treatment emergence was increased, the increase ranging from 8 to 14 per cent.

Only one ounce of copper carbonate was tested. Even at this rate copper carbonate controlled smut almost completely, and at the same time gave as good germination as the untreated checks.

*District trials.*—The results of trials with "Fungus" sulphur made in the district during the last year were so encouraging that it was decided to continue them in the South Central and Gujarat Divisions. At each place local varieties of sorghum were treated with 5 ounces of sulphur dust, and sown in plots ranging in size from half an acre to one acre. In the South Central Division, the seed was artificially infected with a spore dosage of 1-750; but in the Gujarat Division, naturally infected seed was used. At most places an untreated check plot was provided. In the South Central Division check plots were also sown with seed steeped in 2 per cent. copper sulphate.

The results of the district trials, as given in Table V, indicate that in the South Central Division, smut was completely controlled at all places except at Malsiras where 2 per cent. infection was obtained in the plot sown with sulphur-treated seed. In the Gujarat Division, also, uniformly good results on smut reduction were obtained at all places except at Nahir in the Broach District, where the sulphur-dusted plot gave 1 per cent. infection. These results are entirely satisfactory from the standpoint of smut control.

## Experiments in 1930.

In the experiments conducted during 1927 to 1929 inclusive, the sulphur-treated seed was in most cases sown by a pair of forceps in order to have uniform coating of the dust on each grain. The question was raised whether the data on smut reduction obtained by this method of sowing would be comparable with the amount of smut in the drilled seed, since in drilling the treated seed, some quantity of sulphur on the grains was likely to be removed by hand, and this might adversely affect the control of smut. Experiments were therefore made on the College Farm, Poona, in which one lot of sulphur-treated seed was sown by hand and the other was drilled. The results are recorded in Table VI.

TABLE VI.

*Effect of drilling and dibbling seed on the control of infection, College Farm, Poona. 1930.*

| Treatment | Method of sowing | Per cent. of smut by head count |
|---|---|---|
| Sulphur—5 oz. to 60 lbs. | Drilling | 0·2 |
| Check (untreated)* | Do. | 25·2 |
| Sulphur—5 oz. to 60 lbs. | Dibbling | 0·4 |
| Check (untreated)* | Do. | 32·8 |

* The seed was artificially infected with spore dosage of 1·750.

A reference to the table will show that there was no difference in smut reduction in the plots in which the seed was drilled or sown by hand. The amount of smut in the drilled and dibbled checks was also about the same.

TABLE VII.

*Effect of sulphur dust on the emergence of seedlings grown from treated seed on College Farm, Poona, in 1929 and 1930.*

| Treatment | | Per cent. of emergence | | |
|---|---|---|---|---|
| Dust | Oz. per 60 lbs. | 1929 | 1930 | |
| | | | Treated | Check |
| Sulphur | 8 | 58·5 | 65·7 | 59·8 |
| | 10 | 57·0 | 62·0 | 60·0 |
| | 12 | 68·2 | 62·7 | 58·0 |
| | 14 | 61·2 | 59 0 | 56·3 |
| | 16 | 67·2 | 66·2 | 59·2 |
| | 18 | 62·5 | 60·7 | 59·0 |
| | 20 | 63·5 | 63·7 | 54·2 |

TABLE VII—*contd.*

*Effect of sulphur dust on the emergence of seedlings grown from treated seed on College Farm, Poona, in 1929 and 1930*—contd.

| Treatment | | Per cent. of emergence | | |
|---|---|---|---|---|
| Dust | Oz. per 60 lbs. | 1929 | 1930 Treated | 1930 Check |
| Sulphur . . | 22 | 63 7 | | |
| | 24 | 67·7 | | |
| | 26 | 64·0 | | |
| | 28 | 59·5 | | |
| | 30 | 65 7 | | |
| | 32 | 64 5 | | |
| | 34 | 76·7 | | |
| | 36 | 63·2 | | |
| | 38 | 68 5 | | |
| | 40 | 73 7 | | |
| | 42 | 62 5 | | |
| | 44 | 64 5 | | |
| | 46 | 63·2 | | |
| | 48 | 61·7 | | |
| | 50 | 68·2 | | |
| | 52 | 65·0 | | |
| | 54 | 65 5 | | |
| | 56 | 67·0 | | |
| | 58 | 68·7 | | |
| | 60 | 69·5 | | |
| | 62 | 69·5 | | |
| | 64 | 62·7 | | |

## Effect of sulphur dust on seed germination.

It is generally known to cultivators in the Bombay Presidency that a 2 per cent. copper sulphate solution does not cause injury to germination of sorghum seed. Johnston and Melchers [1928] have come to a similar conclusion in their experiments made in Kansas. It has also been shown in the experiments reported herein that the chemical dusts, with the possible exception of dehydrated copper sulphate, caused practically no injury when compared with the untreated checks. In fact, in most cases the treated seed gave a better stand, which might probably be due to the disinfectant freeing the seed from saprophytic as well as parasitic fungi. Since sulphur was the best of all the dust fungicides tested in these experiments, it seemed desirable to ascertain whether sulphur applied at rates higher than 5 ounces per 60 lbs. of seed, would cause injury to the seed. It was realised that, if sulphur applied at any rate was harmless to the seed germs, it would be possible to induce the farmer to treat his seed as a part of the farm routine, since the dust would not injure seed germination even in the hands of a careless cultivator.

Experiments were made on the College Farm, Poona. In 1929 the seed was treated with " Fungus " sulphur at rates ranging from 8 ounces to 64 ounces of the dust to 60 lbs. of seed. It was, however, found that sulphur applied at rates higher than 20 ounces did not adhere to the seed, and in 1930 only 8 to 20 ounces of the dust were tested. The results of these experiments, as recorded in Table VII, indicate that the higher doses of sulphur had no deleterious effect on the emergence of seedlings. In 1930 the treated seed invariably gave better germination than the untreated checks. It is evident therefore that sulphur dust improves the germination of seed and exerts no harmful effect even when 64 ounces of sulphur are used to treat 60 lbs. of seed.

## Feeding experiments with sulphured grain.

The most undesirable feature of the liquid copper sulphate treatment is that it makes the grain poisonous, so that if any portion of the treated seed is not sown; it cannot be used for human consumption, nor can it be fed to the cattle. This difficulty has been one of the reasons why this treatment has failed to become popular with the cultivators in the Bombay Presidency. It has been shown in the experiments reported herein that only 3 to 4 ounces of sulphur are required to treat 60 lbs. of smutted sorghum seed. It was thought that such seed, when fed to the cattle, was not likely to produce any harmful effects, since sulphur in small doses is known to possess pharmacological properties. Experiments were therefore made at

the Poona Agricultural College Dairy to ascertain the effect of feeding sulphured grain on the cattle.

Six buffalo calves, 8 to 11 months old, were selected for the experiment and divided into two lots of three calves each. One lot was fed on the grain dusted with "Fungus" sulphur at the rate of 4 ounces per 60 lbs. of seed, and the second lot was fed on the grain treated with 5 ounces of dust. The sulphured seed was kibbled by a country grain grinder and was then gradually incorporated in the daily ration of the calves as per schedule below :—

From 19th to 25th May at the rate of 2 ozs. per head daily.

From 26th to 28th May at the rate of 4 ozs. per head daily.

From 29th May to 2nd June at the rate of 6 ozs. per head daily.

From 3rd to 6th June at the rate of 8 ozs. per head daily.

The experiment was started on 19th May and concluded on 6th June, 1929.

The animals which were daily examined for consistency of the dung, colour of the urine, temperature of the body and general condition, did not show any ill effects during the period of the experiment, even after half a pound of sulphured grain was fed per head per day. The animals also gained in live weight; but since no control calves were provided, it is not possible to conclude that the beneficial effects were due to the feeding of sulphured grain.

Another experiment was commenced on 1st August, 1929, in which eight calves, about two years old, were divided into two groups of four calves each. The calves in group A were fed on sulphur-dusted sorghum treated at the rate of 5 to 6 ozs. of dust per 60 lbs. of seed, while those in group B served as control. Each group was given the same unit of fodder (maize) *ad lib.* throughout the experiment. The calves in group A were given a concentrate mixture *plus* sulphured sorghum, the total amounting to 1 lb. for each animal. The sulphur-dusted sorghum was gradually incorporated into the daily ration of the calves, the maximum quantity fed being ½ lb. for each animal per day. The calves in group B were given 1 lb. concentrate mixture only. The experiment was concluded on 14th August, 1929.

The results of this experiment, as recorded in Table VIII, indicate that no ill effects of any kind were produced in the animals fed on sulphur-dusted grain. On the other hand, these animals gained more in weight than the animals in the control group B, which were not fed on sulphured grain. It may, however, be noted that these data are not sufficiently conclusive to attribute the difference in weights of the two groups of animals to the feeding of sulphur with sorghum.

TABLE VIII.

*Effect of feeding sulphur-dusted sorghum grain on buffalo calves at the Poona Agricultural College Dairy in 1929.*

| | Total weight of all animals | | Consistency and colour of dung | Colour of urine | Body temperature | General condition |
|---|---|---|---|---|---|---|
| | Initial | Final | | | | |
| | lbs. | lbs. | | | °C. | |
| Group A . . . | 1,064 | 1,165 | Soft, greenish . | Slightly yellowish | 100 | Good |
| Group B . . . | 1,064 | 1,152 | Ditto . | Ditto . | 100 | Do. |

## DISCUSSION AND CONCLUSIONS.

It is evident that all the three dust fungicides controlled grain smut as effectively as liquid copper sulphate. The advantages of dusts are obvious: they are easier to apply and cheaper than liquid preventives, and the treatment of the seed can be done weeks prior to seeding without material injury to the vitality of the grain.

Copper carbonate dust was as effective in controlling smut as the other two dusts, and the results obtained with this fungicide are in agreement with those reported in an earlier paper [Uppal and Malelu, 1928] and by Johnston and Melchers [1928] in Kansas. There was no evidence that the dust had any stimulatory effect on the germination of seed as is often reported with wheat treated with copper carbonate [Mackie and Briggs, 1923]. Although the treatment is very satisfactory, it has the disadvantage that the copper carbonate-treated seed is poisonous to the cattle.

Copper sulphate dust gave as effective control as the liquid treatment; but unless the dust is applied in a very fine state, it does not adhere properly to the seed. In wet weather copper sulphate absorbs moisture and becomes very difficult to apply. It is therefore unlikely that this treatment will be of practical value under the conditions of the Bombay Presidency. The dust has also been investigated in the control of bunt in wheat [Mackie and Briggs, 1923]; but it has not found favour because of its effect on the vitality of the grain. It, however, does not exert any deleterious effect on the germination of sorghum seed.

Sulphur dust seems to be the best fungicide and was surprisingly effective. The results are in agreement with those reported in an earlier paper [Uppal and Malelu, 1928] and by Johnston and Melchers [1928], and indicate that sulphur can as

effectively control smut as copper carbonate or copper sulphate. It is much cheaper than any of the dust or liquid treatments. Although no marked stimulatory effect was observed, the dust caused no injury to seed germination, which was considerably improved in many cases. Being a non-poison, sulphur dust is much safer in the hands of cultivators than copper sulphate or copper carbonate. The sulphur-treated seed can be stored indefinitely as sulphur does not absorb moisture from the air. The seed can also be fed to the cattle without ill effects. However, the essentials for the success of the treatment are that finely divided sulphur should invariably be used, and that it should be so applied that the seed is uniformly coated with the dust before it is sown. The sulphur treatment promises to revolutionize the practice of treating sorghum seed for smut control in the Bombay Presidency, and its simplicity and low cost will make it possible for every cultivator to treat his seed as a part of the farm routine at the seed-time.


## SUMMARY.

1. This paper summarises the results of an investigation into the control of the grain smut of sorghum by dust treatments, carried out during 1927 to 1930 inclusive.

2. Three dust fungicides were tested for their effectiveness in controlling grain smut.

3. Copper carbonate dust applied at the rate of two ounces or more to 60 lbs. of seed effectively controlled smut for all dosages of spores. Even one ounce of the dust was effective when the seed was not blackened with spores. The dust did not cause injury to seed germination; but there was no evidence that the fungicide had any special stimulatory effect.

4. Copper sulphate dust was as effective in controlling infection as copper carbonate; but it does not retain its powdered form for long as it absorbs moisture from the air. No deleterious effect on seed germination was observed.

5. Sulphur dust is probably the best fungicide for grain smut control. It is as effective as copper carbonate or copper sulphate, and is much cheaper than either of the latter dusts. It costs much less than one pie per acre in the Bombay Presidency.

6. Sulphur dust gave the best results in smut control in the district trials made all over the Bombay Presidency.

7. Sulphur applied in as large quantities as 64 ounces per 60 lbs. of seed did not cause injury to seed germination. There was a beneficial effect on emergence in most cases.

8. In the feeding experiments in which sulphur-dusted sorghum grain was fed to buffalo calves, no ill effects of any kind were observed when compared with control

animals. In fact, there was evidence to indicate that calves fed on sulphured grain gained more in live weight than the checks.

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# PRELIMINARY INVESTIGATIONS ON THE OCCURRENCE OF STERILITY IN RICE (*O. SATIVA*).*

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CONTENTS.



## I. INTRODUCTION.

It should be the endeavour of every breeder to get the maximum outturn from the crop he grows. The maximum performance of the plant depends firstly upon its being grown under the optimum environmental conditions, and secondly upon its own hereditary make-up being what is most desirable. Change of environmental conditions brings about profound changes in the life of the plant, sometimes even masking its hereditary make-up. The yield of any plant is the end result of several complex processes reacting on the plant throughout its life. To aim at what constitutes high yield we must try to analyse and understand these complex processes. One of the causes of low yields of economic crop plant is the occurrence of sterility, either partial or complete, in its population. There have been instances in our work in rice where hereditary complexes brought about by hybridization had completely suppressed the reproductive phase in the plant, and also where growing the plant in the wrong season had delayed the reproductive phase considerably, and made it less fruitful even when it appeared later. Sterility is sometimes brought about by the attacks of insects like the stem borer and the rice bug. There is also sterility caused by the attack of the fungus *Piricularia oryzae*. These are so easily discernible and are not dealt with here.

## II. DIFFERENT FORMS OF STERILITY.

By the term sterility is here meant the normal occurrence of unset spikelets interspaced with well-set spikelets in the panicle of rice varieties. This is also

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PLATE XXXV.

Fig. 2. Rudimentary spikelets at the base of panicle.

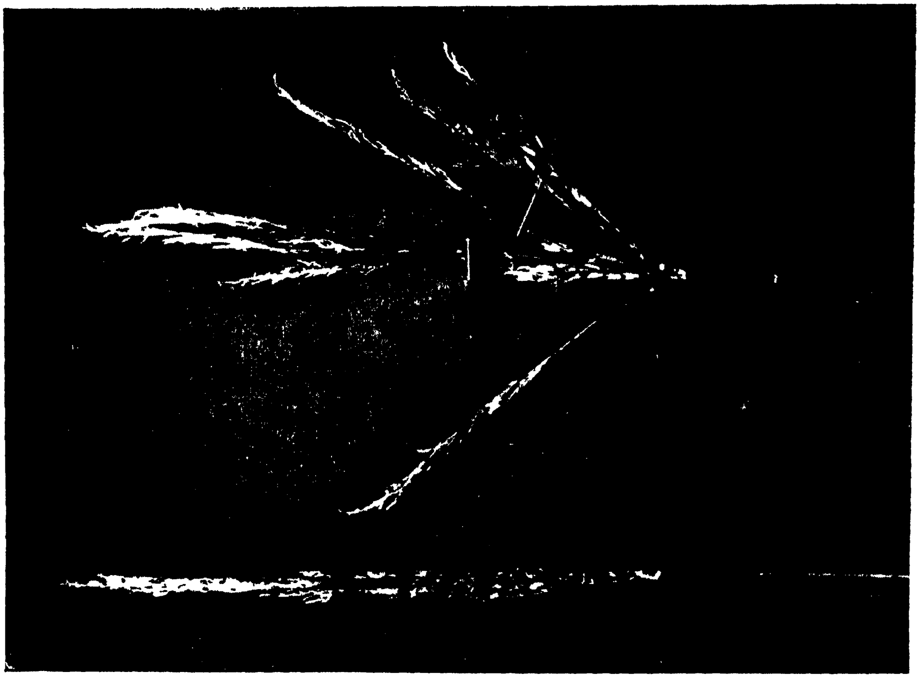


Fig 1. Rudimentary spikelets at the terminal portions.

different from another form of sterility known as *sterile tips* or *sponginess*, which sometimes occurs in certain rice varieties. The spikelets at the terminal portions of the main spike or sub-spike remain rudimentary and undeveloped (Plate XXXV, fig. 1). They are white and papery in appearance and dry up and fall off later as the panicle ripens. These rudimentary spikelets are sometimes observed at the base of the panicle, (Plate XXXV, fig. 2). Here both the ovaries and the anther sacs are aborted. This form of sterility has been found to be a varietal characteristic often associated with particular grain sizes and arrangement. It is a Mendelian character, a simple recessive to the normal spikelet, and it is also known that the incidence of the sterile tips can be enhanced by excessively manuring the field in which the plants are growing.

The sterile spikelets dealt with in this paper are found to contain all the essential organs normally developed. Its occurrence is not easily made out in the beginning but becomes obvious as the panicle ripens. The glumes of the fertile spikelets change colour as the grain inside ripens, and assume the ripening colour characteristic of the variety, as gold, black, dark brown, straw, etc., while those of the sterile spikelets continue to exhibit the original green colour and ultimately turn straw.

The loss resulting from this kind of floret sterility in rice is considerable. When grown under optimum conditions a large number of varieties of rice exhibit very little of this defect, but certain others always show it to a varying extent year after year. The effect of unfavourable conditions at the flowering period which is known to produce sterility even in normally fertile varieties is particularly manifest in such inherently poor varieties. This is evidently a wild character as it is particularly bad in the wild and the semi-wild rices. Although spikelets are produced in abundance, very few of them develop any grain. Generally the grains of the wild rices shatter even before they are ripe, but the sterile spikelets remain in the panicle for a much longer time. A number of pure lines in the collections at Coimbatore have been examined for this character, and it is found that the amount of it varies from about 2 to 40 per cent. In general, the varieties of rice that have a long awn on the spikelet do not set so well as others without it, although there are one or two exceptions to this finding. Whether the presence of awns mechanically interferes with the normal pollination or whether there is any genetic relation between awning and sterility, cannot be stated without further investigations. It is also found that among the varieties that normally show a fair amount of sterility a good number are of early duration. Whether there is any thing more definite about this beyond the influence of the season is being investigated into. There is a particular extracted type in the pure line collections obtained from the progenies of a cross which exhibits as much as 95 per cent. floret sterility. This is probably a self-sterile plant that arose by mutation. In Japanese publications we find numerous instances of the occurrence of sterile and semi-sterile plants by mutations. [Isabura Nagai, 1926-27]. Self-sterility is stated to be a simple Mendelian recessive to self-fertility [Terao, 1922].

### III. Effect of environmental conditions on sterility.

One of the chief environmental conditions that affects this character is the time of planting the crop, or rather the time at which the blooming takes place. It is recognised that every variety of rice has an optimum season, and growing it in the wrong season results in poor yield, one of the contributing causes for such low yields being the occurrence of sterility. Two of the Coimbatore strains have been grown at the Paddy Station for the last 5 years, the sowings taking place at regular intervals during the whole year*. The study was mainly intended for finding the optimum time for planting the crop and to determine the effect on yield by growing it at different times. To assess the differential yield records the amount of sterility was determined for each sowing, and Table I gives the results obtained.

Table I.

*Behaviour of two strains, GEB. 24, and Co. 3, sown at different times of the year 1927-28.*

| Time of sowing | GEB. 24 | | | Co. 3 | | |
|---|---|---|---|---|---|---|
| | Total yield of plot in grams | Average number of ears per plant | Percentage of unsetting | Total yield of plot in grams | Average number of ears per plant | Percentage of unsetting |
| July | 4,820 | 7·1 | 19·2 | 5,720 | 5·1 | 15·7 |
| August | 4,750 | 6·8 | 23·3 | 5,360 | 5·9 | 13·1 |
| September | 3,890 | 6·4 | 27·1 | 4,260 | 5·1 | 30·7 |
| October | 4,140 | 7·4 | 15·1 | 3,810 | 5·4 | 19·1 |
| November | 3,050 | 7·4 | 18·6 | 2,690 | 5·5 | 9·9 |
| December | 2,740 | 6·6 | 15·3 | 4,820 | 6·2 | 13·9 |
| January | 820 | 8·3 | 35 3 | 570 | 7·8 | 31·8 |
| February | 4,880 | 8·8 | 5·8 | 2,390 | 6·6 | 12·6 |

(*N.B.*)—1. The total yield was obtained from the same unit area planted for all the sowings.

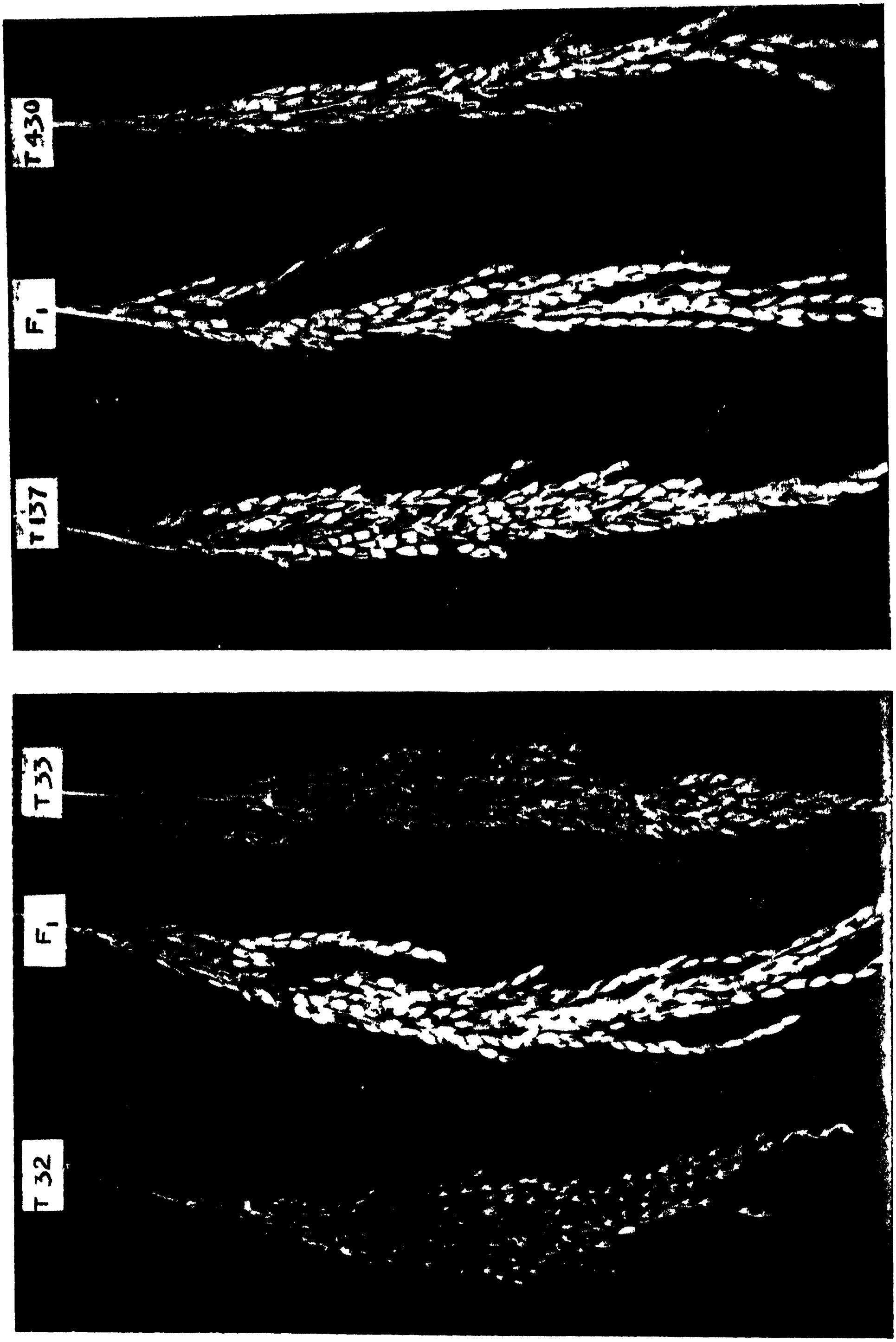
2. The average number of ears per plant was obtained from 100 plants taken at random throughout the plot.

3. Percentage of sterility was obtained from actual counting of the set and unset spikelets in 100 primary panicles taken at random.

The results of only one year, 1927-28, are given as it was a good representative of a normal rice season in Coimbatore. The two varieties are different in duration, and from the amount of sterility appearing in the different sowings, it would

* Unpublished results accumulated by the Paddy Specialist in Coimbatore.

PLATE XXXVI.




Two examples showing the occurrence and non-occurrence of sterility in $F_1$.

appear that they have a different optimum time of sowing. Although from comparing the yields very early sowings are to be preferred, it would seem that but for the higher percentage of unsetting obtained, some of the later sowings could have proved far better. The sterility has nothing to do in this case with the vigour of the plant as would be seen from the number of ears formed per plant. Too much of rain during the flowering time, or too dry a condition of the soil at that time when the plants transpire most, are stated to result in a large amount of sterile spikelets in the plant. Too much of fertility in the soil which makes the straw lodge even at the time of flowering on account of over-growth is also known to result in unset spikelets.

## IV. Inheritance of sterility in crosses.

That the spikelet sterility, apart from its incidence due to environmental conditions, is controlled by hereditary factors has become abundantly clear from the study of several artificial crosses made at the station. Some of the crosses mainly intended to evolve high-yielding strains began to exhibit a large amount of spikelet sterility in the $F_1$ $F_2$ and later generations, though it was practically absent in the parents themselves. Plate XXXVI represents two examples showing the occurrence and non-occurrence of sterility in the $F_1$'s. Jones [1930] also refers to the occurrence of such sterility in $F_1$'s and off-springs of crosses between Chinese and Japanese rice varieties. Though hybridization work in rice to build up types having several desirable characters in them is full of promise, and this line of work is being pursued in Coimbatore, the occurrence of sterility in the progenies of several of these will, it is considered, be a limiting factor. The incidence of sterility is particularly apparent in crosses between parents differing rather largely with regard to their characters, like duration, tillering, grain sizes, etc. In a particular cross where there was hardly any sterility in the parents, its amount varied from 4 to 56 per cent. in the $F_2$ generation. We cannot afford to neglect making crosses between parents of widely divergent characters simply because of this sterility difficulty. It has been repeatedly stated by geneticists of repute as a result of their own critical experiments on plants, that the greatest opportunity for plant improvement lay in crossing together types which are as far differentiated from each other as is possible without producing complete sterility in the hybrids. When varieties differing in a large number of allelomorphs can be crossed and the resulting hybrids are fertile, there is a wonderful chance for desirable combinations occurring in the $F_2$ generation. The complex nature of this character becomes apparent while considering its genetic association with other inherited characters in rice as the following instances will show.

## V. Genetic association of sterility with other characters.

1. In one of the crosses, the $F_2$ generation was segregating for the presence of anthocyan pigment at the leaf axil and stigma. This segregation was expected to give a 9 : 7 ratio of pigmented to non-pigmented plants from the known

constitution of the parents. The same family was also found to vary considerably for the amount of sterility exhibited by the plants. The amount of sterile and fertile spikelets was determined quantitatively for each plant and the amount of sterility expressed in percentages. These percentages were tabulated with the plants with and without pigment. Table II gives the distribution of one such $F_2$.

TABLE II.

*Percentage of setting in pigmented and non-pigmented plants in $F_2$ 2723.*

| Percentage of set spikelets | Frequency of plants | |
|---|---|---|
| | Pigmented | Non-pigmented |
| 0—4 | 1 | .. |
| 5—9 | 2 | 1 |
| 10—14 | 1 | 1 |
| 15—19 | 3 | .. |
| 20—24 | 4 | .. |
| 25—29 | 6 | 3 |
| 30—34 | 17 | 2 |
| 35—39 | 30 | 2 |
| 40—44 | 45 | 1 |
| 45—49 | 64 | 4 |
| 50—54 | 109 | 16 |
| 55—59 | 70 | 17* |
| 60—64 | 44 | 24 |
| 65—69 | 20 | 45 |
| 70—74 | 13 | 60 |
| 75—79 | 19 | 104 |
| 80—84 | 14 | 118 |
| 85—89 | 11 | 124 |
| 90—94 | 4 | 57 |
| 95—99 | 3 | 26 |
| Total . . . . . . . | 486 | 605 |
| Mean percentage of setting . . | $53·7 \pm 0·43$ | $78·2 \pm 0·34$ |

PLATE XXXVII.

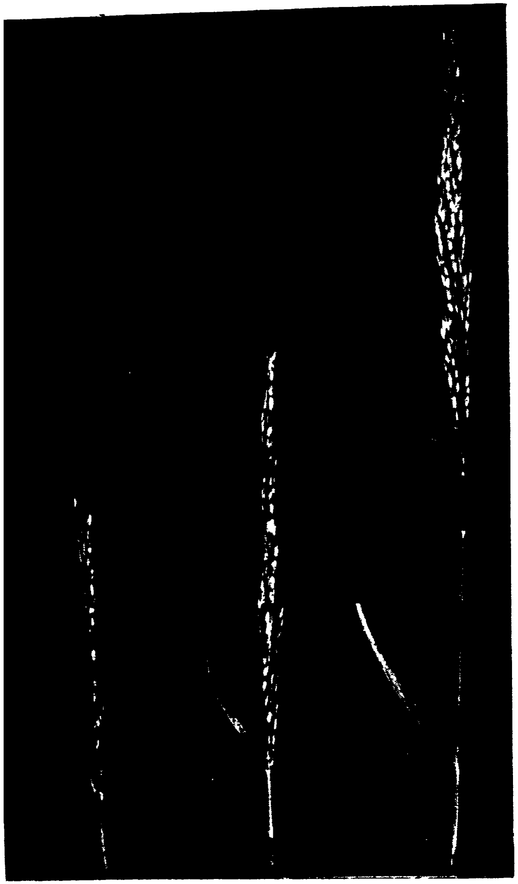
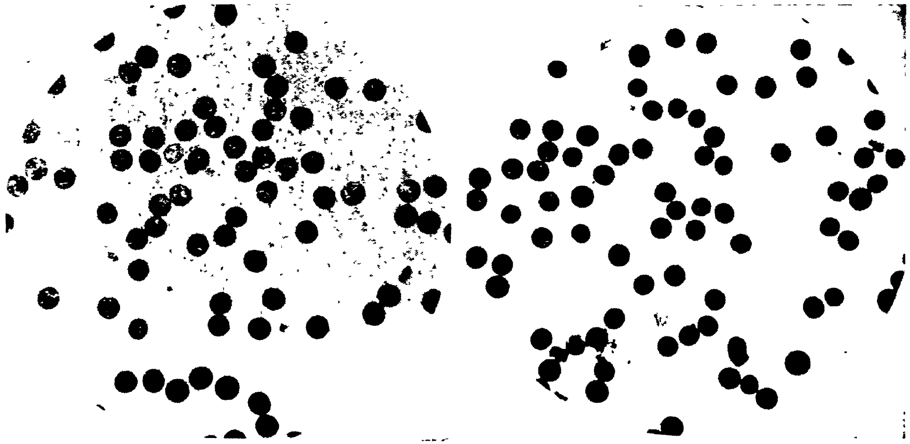
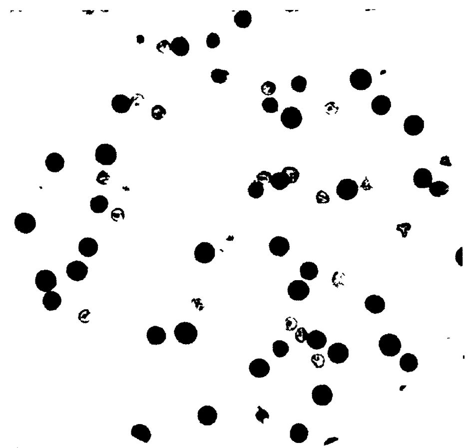


Fig 1. Three panicles from an $F_2$ showing an association between nergence and setting.



Parents.



$F_1$.

Fig. 2. Occurrence of aborted pollen in progeny of parents with normal pollen.

The two means are different, the difference between them being very highly significant in terms of the error. It is apparent that the amount of sterility is definitely greater in the pigment group, thus establishing an association between the pigment factors and the factor or factors responsible for sterility. Although the two parents of this cross were fully fertile, the individuals resembling the parents as regards fertility of the spikelets were considerably less, there being a very large number of partially sterile and fully sterile individuals. The small number of individuals with fully fertile panicles in the $F_2$, and the ease with which a large number of selections from such individuals breeding pure in the later generations would seem to indicate that sterility may be a dominant character in this cross.

2. The second case of association between anthocyan pigment factors and sterility was obtained in another cross where the $F_2$ was segregating for purple and green glumes. The factor responsible for the presence of pigment on the glumes is known from previous work to be different from those responsible for pigment in the leaf axil and the stigma. Here, also, the two parents did not show much sterility though it was present to an appreciable amount in the $F_2$. When the amount of sterility was determined quantitatively for each plant and tabulated with the colour of the glumes, it was found that the purple glumes were slightly more fertile than the green glumes, the difference being significant in terms of the error.

3. Another association of this character recognised in the progenies of a different cross was with the degree of the emergence of the panicle. By the term emergence is here meant the length of the peduncle between the rachis and the leaf-junction of the boot leaf. In some varieties this emergence is several centimetres long, while in certain others the bottommost node of the panicle is either on the same level with, or far below the top leaf-junction enclosed in the leaf-sheath. This quantitative character from other inheritance studies has been proved to be a Mendelian character of the multiple factor type. In the $F_2$'s the variations for the emergence and spikelet sterility were considerable, and the two were quantitatively determined for each plant and then tabulated. This gave a high positive correlation coefficient of $+0{\cdot}92 \ldots {\cdot}02$, proving that the plants with a poor emergence were poor in fertility. Plate XXXVII, fig. 1 represents three panicles from an $F_2$ showing an association between emergence and setting. Morphologically this correlation can be easily understood. The opening of the glumes and the fertilization commence immediately after the panicles emerge out of the top leaf sheath. Stray cases of cleistogamy have been observed where fertilization occurs even without the panicle emerging out and consequently without the glumes opening, though

PLATE XXXVII.

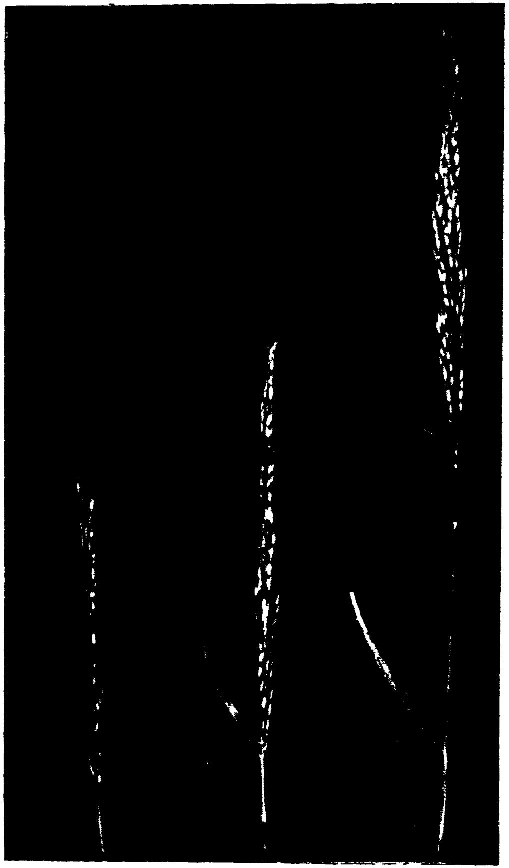
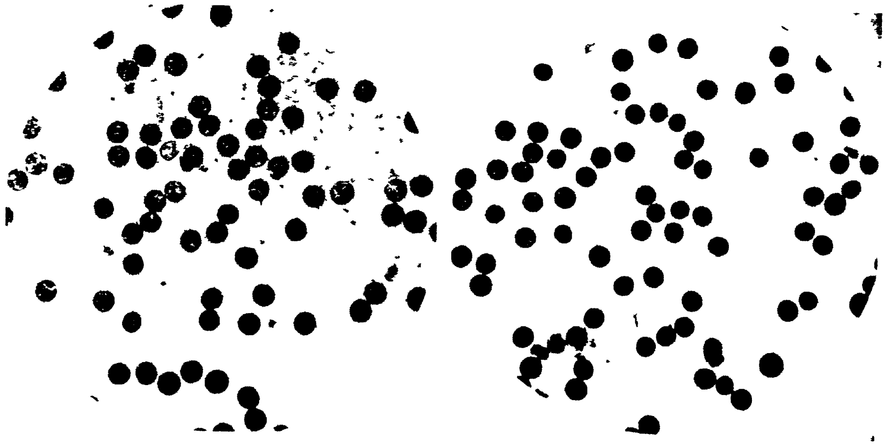
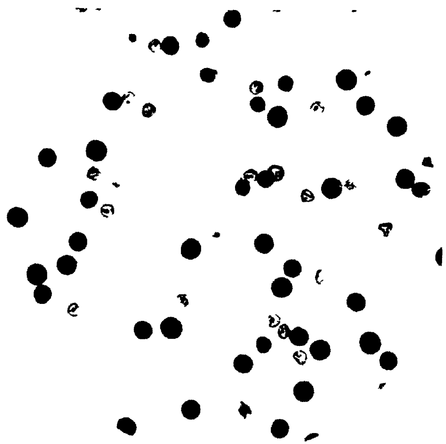


Fig 1. Three panicles from an $F_2$ showing an association between emergence and setting.



Parents



$F_1$.

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for normal fertilization emergence of the panicle from the enclosing leaf sheath would appear necessary. There is another interesting result obtained in this family with regard to the duration of the crop. The same $F_2$ was found segregating for duration, and the joint tabulation of duration and emergence gave a negative correlation of $-0{\cdot}96 \pm {\cdot}05$. This means that all the late plants have got a poor emergence. Since these two correlations are very high, it follows that the correlation between duration and sterility must be positive and high also in this particular family. From the study of a number of $F_2$ families in this cross it was found that all the plants which flowered beyond a certain date, though they grew very vigorous, never produced any grain. This cross establishes the association between sterility on one side and the ear emergence and the duration of the plant on the other. These results have been recently confirmed by Jones [1930] in California.

4. In still another cross both the parents exhibited a certain amount of sterility, about 17 per cent. The parents differed to a large extent in the grain size and its arrangement in the panicle. In the $F_2$ the percentage of sterility varied from as low as 5 per cent. to as high as 80 per cent., and there was an association of sterility and the grain size and arrangement as in Table III.

TABLE III.

*Test of independence in a 2 × n classification of $F_2$ 6203.*

| Grain arrangement | Percentage of unsetting | | | | Total |
|---|---|---|---|---|---|
| | 15 & below | 16—30 | 31—45 | 46 & above | |
| Sparse . . . . . | 269 | 259 | 66 | 10 | 604 |
| Bunched . . . . . | 26 | 97 | 58 | 6 | 187 |
| Total . . | 295 | 356 | 124 | 16 | 791 |
| | 4,057,935 | 289,674 | 1,298,678 | 192,282 | 5,838,569 |

$$X^2 = \frac{5838569}{112948}$$

$$= 51{\cdot}7.$$

$$P = {\cdot}0000$$

Applying the test of independence, the value of P is a very insignificant fraction showing that so far as this particular character, setting of spikelets, is concerned,

the distribution of the two groups "Sparse" and "Bunched" are absolutely independent. The plants with a small grain and a closely packed arrangement in the panicle showed rather more of sterility than those with a big grain and a sparser arrangement.

5. There is also an indication of a genetic association, and this has not yet been worked out, between the glutinous character of the rice endosperm and sterility.

The above-mentioned instances have all been obtained by crossing rice varieties of the same species, *O. sativa*, all apparently having the same number of chromosomes. The sterility may be brought about either by defects in the morphological parts or to physiological factors as a result of inherent factors for such defects. Sterility may be caused not only when a perfect sexual combination has failed to be secured, but also by the fertilized egg not developing after fertilization.

In crosses attempted between *O. sativa* and *O. longistaminata*, and between *O. sativa* and *O. latifolia*, the cross-pollinated spikelets appeared well-formed and even developed the characteristic ripening colour of the mother plant which is not usual with a non-fertilized spikelet. But when these spikelets were later harvested they were found to yield to pressure between fingers and when the husk was removed and examined, it was found that there was hardly any endosperm although the seed-coat was formed. This was suspected as a case of single fertilization instead of the usual double due to abnormal nuclear division. This suspicion is confirmed by the work of Japanese breeders [Suzuta and Suemata, [1928] who have obtained similar results independently.

## VI. Sterility where most apparent.

Several of the pure lines which normally exhibit a large percentage of sterility have been examined carefully for two seasons. This examination gives some indication as to its order of occurrence.

The rice plant does not produce earheads all at once, but these come on gradually in the same order of tiller formation. The order of earheads was marked as 1, 2, 3, and so on for a number of plants in each variety, and the amount of sterile spikelets in each ear determined separately. The amount of sterility in the individual plants, and the individual tillers of each plant, was found to vary considerably.

In two of these varieties showing sterility all the spikelets of all the panicles in a plant were marked out in a chart and the flowering date of each individual spikelet noted in the chart, and records kept about the fertility or sterility of each spikelet. Generally it takes 4 to 7 days for a single panicle to finish flowering, and this period is reduced in the case of later formed panicles in the same plant. When the days of flowering of individual spikelets in each panicle in the order of their formation are tabulated, not only is there a definite increase of sterility in the later heads, but all the sterile spikelets are practically confined to those flowering in the end of the blooming period (Tables IV A and IV B). Fig. 1 depicts graphically the average percentage of sterility of flowers opened during the blooming period. The sterile spikelets are also confined to the basal portions of the branches at the lower half of the panicle.

### Table IV-A.

*Order of flower opening and distribution of sterile spikelets in individual panicles of a plant. Type K-74.*

| Date of flower opening | First ear | | | Second ear | | | Third ear | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total number of flowers opened | Number of unset flowers | Percentage of un-setting | Total number of flowers opened | Number of unset flowers | Percentage of un-setting | Total number of flowers opened | Number of unset flowers | Percentage of un-setting |
| August 21 | 20 | 0 | 0 | 11 | 0 | 0 | .. | ... | ... |
| 22 | 18 | 0 | 0 | 23 | 1 | 4 | 13 | 0 | 0 |
| 23 | 27 | 2 | 8 | 16 | 0 | 0 | 30 | 0 | 0 |
| 24 | 11 | 7 | 63 | 13 | 6 | 46 | 26 | 2 | 8 |
| 25 | 7 | 7 | 100 | 9 | 9 | 100 | 21 | 13 | 60 |
| 26 | 3 | 3 | 100 | 3 | 3 | 100 | 11 | 11 | 100 |
| 27 | ... | ... | ... | ... | ... | ... | 7 | 7 | 100 |
| Total . | 86 | 19 | 22 | 75 | 19 | 25 | 108 | 33 | 31 |

TABLE IV-B.

*Order of flower opening and distribution of sterile spikelets in individual panicles of a plant. Type 252.*

| Date of flower opening | First ear | | | Second ear | | | Third ear | | | Fourth ear | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number of flowers opened | Average number of unset flowers | Percentage of unsetting | Average number of flowers opened | Average number of unset flowers | Percentage of unsetting | Average number of flowers opened | Average number of unset flowers | Percentage of unsetting | Average number of flowers opened | Average number of unset flowers | Percentage of unsetting |
| September 27 . . | 9 | 1 | 11 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| „ 28 . . | 22 | 1 | 5 | 1 | 0 | 0 | ... | ... | ... | ... | | ... |
| „ 29 . . | 48 | 2 | 4 | 14 | 0 | 0 | 6 | 0 | 0 | ... | | ... |
| „ 30 . . | 38 | 2 | 5 | 28 | 0 | 0 | 14 | 0 | 0 | ... | ... | ... |
| October 1 . . | 28 | 18 | 64 | 34 | 3 | 9 | 28 | 1 | 4 | 9 | 0 | 0 |
| „ 2 . . | 14 | 13 | 93 | 25 | 11 | 44 | 29 | 7 | 24 | 17 | 0 | 0 |
| „ 3 . . | 8 | 8 | 100 | 16 | 13 | 81 | 21 | 13 | 62 | 28 | 14 | 14 |
| „ 4 . . | 1 | 1 | 100 | 7 | 7 | 100 | 9 | 9 | 100 | 22 | 9 | 41 |
| „ 5 . . | ... | ... | ... | 3 | 3 | 100 | 4 | 4 | 100 | 14 | 10 | 71 |
| „ 6 . . | ... | ... | ... | ... | ... | ... | 2 | 2 | 100 | 4 | 4 | 100 |
| „ 7 . . | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2 | 2 | 100 |
| Total average . | 168 | 46 | 27 | 128 | 37 | 29 | 113 | 37 | 33 | 96 | 29 | 30 |

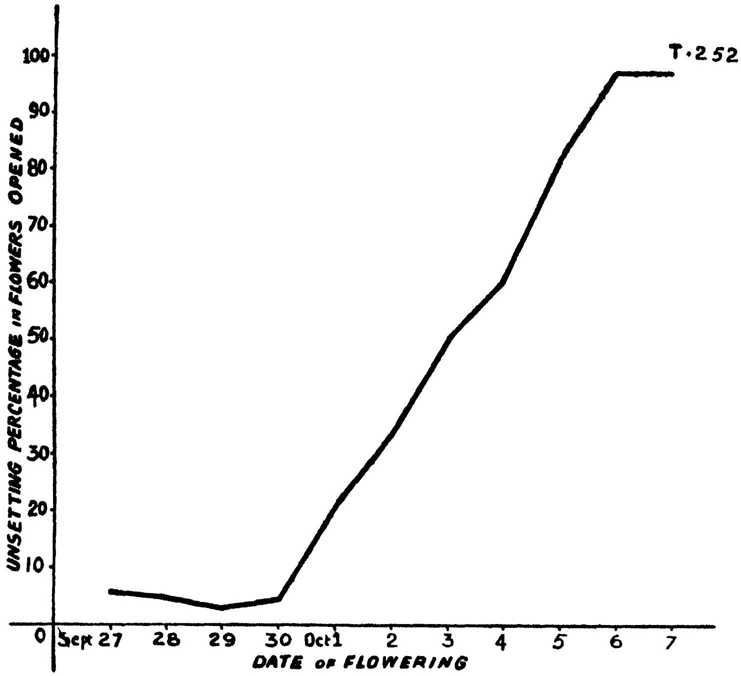


Fig. 1.

## VII. Causes of sterility.

In connection with the studies about sterility all the following points will have to be investigated into : (1) special features of the essential parts of the flower, the stigma and the pollen grains, (2) the structure of the pollen grains and its viability, (3) germinating the pollen grains under artificial conditions, (4) receptivity of the stigma, etc. All these various lines of investigations are being pursued and some results are already obtained. These will form the material for a separate publication.

The structure of the flower and its essential parts have been examined rather carefully in some of the pure lines conspicuous for their sterility. The opening of the glumes in rice and the dehiscence of the anthers are greatly influenced by the prevailing atmospheric temperature and humidity. Within narrow limits every variety has its own optimum temperature and starts blooming when that temperature is attained [Ramiah, 1927]. In normal cases the anther sacs are fully mature at the time of flower opening and they immediately dehisce and shed their pollen. In some of the cases examined it was found that the anther sacs had emerged out and dried up without dehiscing. The size of the anther sacs occurring in such sterile spikelets were slightly smaller than the normal ones, and they did not attain the bright yellow colour of the normal anthers. The pollen grains

when examined under the microscope were found to be almost empty and in a collapsed condition. Sterility in this case must be entirely due to the defective pollen, and this appears to be the most common cause for the occurrence of sterility in rice. Plate XXXVII, fig. 2, shows that occurrence of aborted pollen in an $F_1$, while the pollen of the two parents are normal.

With the rapid growth of the anther filaments just at the flowering time there is a simultaneous growth of the stigmas as well. At the time of the anther dehiscence the style branches of the stigma open out and show a tendency to come out of the glumes at the sides, so that when the glumes close again the stigmas are caught invariably between the glumes with their tips remaining outside. In such cases even if self-pollination does not take place, there is the possibility of the stigma getting the pollen from the spikelets situated above in the same panicle, or from other spikelets in the same plant. If the stigmas do not grow simultaneously with the anthers, as it appears to do in some of the observed cases where sterility is found to occur, the stigmas remain inside the glume and when the glumes close again they loose all chances of getting pollinated. The normal self-fertilization, therefore, appears to depend on the simultaneous maturity of the anthers and the stigma. If the temperature and humidity are artificially increased around the panicles by enclosing the panicle in a paper or cloth cover, the anther filaments elongate much more rapidly than the stigmas, but the anthers do not dehisce, and by the time the glumes close again the stigmas are still inside without getting pollinated. This is found to be the cause of sterility occurring in certain plants which are enclosed in a cloth bag for selfing purposes, which is resorted to in the case of the $F_1$'s of artificial crosses. Whether such a thing could happen in Nature and account for the sterility that often occurs in varieties we cannot say. But still most of the stigmas of the sterile spikelets when examined appear to be quite fresh and healthy with the stigmatic hairs turgid for a long time after the opening and closing of the glumes. While the fertilized stigmas shrivel up after some time, the healthy condition of the stigmas inside the sterile spikelets would appear to show that the sterility must be due to want of pollination.

The apparent healthy condition of the pollen grains cannot be construed as a positive evidence of ability to function. In two of the varieties showing sterility, a number of ovaries with the stigmas well smeared with pollen grains were carefully removed about 4 hours after pollination, cleared in KOH solution, and examined under the microscope. It was found that though all the stigmas had the pollen on, over 50 per cent. of the stigmas did not show any pollen tube. Sterility in this case may be due to defective stigmas as well as ovaries, as they failed to show any pollen tubes even when artificially pollinated with healthy viable pollen. In *O. longistaminata*, a normally sterile wild rice, it is found that the pollen germinate on the stigma and send out tubes which can be traced only up to the stylar tissue.

## VIII. Summary.

Sterility or faliure to produce grain is one of the contributing causes of low yields of a crop. There are several forms of sterility brought about by various causes, but the one discussed in this paper refers to the common form where a varying number of spikelets in the panicle remain unset, interspaced with well-set spikelets. This form of sterility is caused by influences both environmental and hereditary. Among the environmental influences the season at which the crop is grown plays an important part.

When the large number of pure line collections at Coimbatore are examined, it is found that this sterility occurs to a small extent in a great many of them, and to a large extent in a few of them repeatedly year after year. The inheritance of this character is complicated, and has not yet been worked out completely. Sometimes even when the parents of a cross are absolutely free from this defect, the $F_1$, $F_2$ and later generations of the cross exhibit the same to a varying extent; the wider the difference between the parents with regard to their characters, the greater is the amount of sterility in the progeny.

Studies in the progenies of artificial crosses made at the Paddy-Breeding Station, Coimbatore, show a partial association of this character with characters like presence of anthocyan pigment in particular parts of the plant, the duration of the plant, the degree of emergence of the panicle, and the size and arrangement of the grain in the panicle.

In crosses attempted between *O. sativa* and two other species of *Oryza*, *O. longistaminata* and *O. latifolia*, there is evidence of single fertilization instead of the usual double due to abnormal nuclear division.

When varieties where a large amount of sterility occurs are examined critically, it is found that its incidence is mostly confined to the spikelets that flower towards the end of the blooming period, and these are usually situated at the base of the bottom branches of the panicle.

Examination of the floral parts of the sterile spikelets would show that sterility is due to uneven maturity of the pollen and the stigma, aborted pollen, and non-functioning of the pollen even when well-formed. There are a few instances where sterility may be put down as due to defective stigma.

*Acknowledgments.*—Use has been made in the preparation of this paper of some of the unpublished results collected by F.R.Parnell to whom the author is indebted.

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# ROCK SALT AND ITS USE FOR GRAZING ANIMALS.*

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## INTRODUCTION.

Salt (sodium chloride) is as essential as food to cattle to build up the body and maintain health. In Western India, the use of salt is limited to milch animals, working bullocks and bull-calves, and it is usually mixed with the ration. But other animals such as dry cows and non-working bullocks are quite neglected in this respect. However, from the study of the habits of the grazing animals it is evident that the animals desire and try to get salt by licking rock, soil, ash and their own body or that of other animals.

Watt [1893] gives the same opinion :—" It has never been the general practice to give salt habitually to cattle, especially grazing cattle (which constitute the majority), except as a religious observance or as medicine when sick.

The results of our experiments regarding the use of salt to grazing animals have since 1925 been found very interesting and useful; and they are described in this short paper with a view to benefit those interested in pasture improvement and cattle management.

## ROCK SALT—ITS OCCURRENCE, DISCOVERY, DISTRIBUTION, APPEARANCE AND COMPOSITION.

Salt usually occurs as sea salt and rock salt. But it is the rock salt which is liked by grazing animals. It is a mineral deposit and was first discovered in 1837 in Thurungia at Artern and later in Strassfurt, Germany. Rock salt deposits occur in beds interstratified with sedimentary rocks and are often closely associated with gypsum. Its deposits in Germany extend over wide areas and are of vast thickness.

Of the salt produced in India, about eleven per cent. is made from the rock salt. It occurs in two regions in the north-west corner of the Punjab, in solid beds which generally underlie the thickest development of gypsum.

Rock salt is usually colourless in mass and white after pulverization ; but when impure, it is brownish red or yellow. It is generally in compact crystalline masses.

*Paper read at the Agriculture Section, Indian Science Congress, Nagpur, January 1931.

The following is the average composition of rock salt from the Mayo Mines [Harris, 1907]:—

| | Per cent. |
|---|---|
| Earthy matter | Trace. |
| Calcium sulphate | 0·75 |
| Calcium chloride | 0·50 |
| Magnesium chloride | 1·25 |
| Sodium chloride | 93·00 |
| Water and loss | 4·50 |
| Total | 100·00 |

It will be seen from the above table that rock salt in its fine crystalline mass, having a small amount of hygroscopic salts, is better suited as a cattle-lick on grazing areas.

## PRELIMINARY EXPERIMENTS.

Our first trial regarding the use of rock salt was made in 1925 on poor pasture of 37 acres at Padmavati, near Poona, with a herd of 25 cattle consisting of milch animals, working bullocks and calves. Salt blocks weighing about a pound each were placed in two places on the area. At the beginning the animals were so frightened that they ran away from the salt spots. Later on, in about two weeks, a taste was created by offering the salt blocks by hand to the animals and they gradually began to like it. In a month's time the whole herd was found freely licking the salt blocks with great avidity while grazing. One day one animal was actually found running after the salt when it was being shifted to another place.

With the help of salt, the coarse feed which would have otherwise been wasted was mostly consumed that year by the animals. By licking salt, the animals got more thirsty and drank oftener.

Similar experience was gained at Mehrun, near Jalgaon (East Khandesh), and also at Chharodi, near Ahmedabad.

## DETAILED STUDY.

A detailed study regarding the use of rock salt has been in progress since 1928 on a poor pasture of 40 acres divided into four blocks of 10 acres each and fenced all round, at Bhamburda forest, near Poona, where arrangements for drinking water for 20 animals have been made. Our observations since then have thrown more light on the improvement of pasture and also on the control of animals.

Here also animals in the beginning did not touch salt, but, later on, they gradually took to it and liked to such an extent that they actually followed the man who removed the salt-blocks from place to place. Many a time an aggressive animal

continued licking for about half an hour and did not allow others to approach. This fact made us distribute salt-blocks at several instead of at one or two places on the area where grazing was to be done. This distribution prevented competition and facilitated free access for every animal.

*Size of blocks.*—The most convenient size of the block that has been found after long experience is not less than four pounds in weight having a flat surface on which the animal can lick larger area. This block, after constant licking, gets worn hollow. When it is found difficult for the animal to lick, owing to the sharp edges of this piece, it is either picked up into the mouth and ground between the molars, or left untouched and thus goes to waste. Pieces smaller than eight ounces in weight are actually eaten.

*Receptacle.*—The most convenient and suitable receptacle for placing the salt-blocks is a rectangular wooden box, 1½ feet long, 1½ feet broad and ½ foot thick, with lead-plated borders. Such a box costs four annas and it lasts for two years. It is placed on the ground supported with medium-sized stones all round. By this arrangement the box is kept steady and not easily displaced by the animals while licking. Besides, the box looks conspicuous on the area and no animal can miss it. Previous to the use of this box, the salt-block was kept on ground, but it was often displaced by the licking animals and many a time the salt block was recovered with great difficulty as it was carried out of sight into the bush or shrub and thus ultimately wasted. In Texas, U. S. A. [Talbot and Chapline, 1926], salt is usually placed in logs or troughs, and this arrangement has so far been found satisfactory, since it allows several animals at a time to use it, and also is not displaced while being used.

*Consumption.*—Our experience with the study of over two years (1928-1929) shows that the consumption, on an average, of salt, during the rains, cold season and hot weather, roughly comes to 2·3, 1·7 and 2·5 pounds per animal per month, respectively. In the hot weather when there was no grazing on the area, animals were stall-fed, and salt-blocks were placed before certain groups of animals in the stall. So on an average, irrespective of the season, each animal consumed 2·16 pounds of salt per month. Experience in Texas, U. S. A., is that consumption during the rainy season is from 2 to 2·3 pounds and in other seasons it varies from 1 to 1·5 pounds per animal per month.

Consumption also depends upon another factor, *viz.*, the nature of feed. Animals when kept grazing on a stuff like the annual *Andropogon contortus*, just at the flowering time, and also when kept on coarse and more matured stalks of perennial species, like *Andropogon monticola* and *Ischaemum laxum*, consumed 3·78 pounds per month per animal. While they were feeding on the fresh growth after the main harvest

was made the consumption of salt was only 0·93 pounds per animal per month. In Ohio and Texas, U. S. A., the experience is quite the reverse [ Talbot and Chapline, 1926 ]. While feeding on drier and more matured stuff the consumption was less, and green succulent feed required more salt. Our observations on this point are yet to be confirmed.

*Effect of salt on animal.*—In the absence of comparative figures nothing definite can be said. Still, it can fairly be said that animals looked healthy. Besides other interesting points noted are that (*a*) animals were easily controlled and turned very easily wherever they were required to be in the area; (*b*) that animals after being used to lick salt almost forgot the habit of licking rock, soil, ash and the body of other animals which was so common and frequent before; (*c*) salt facilitated the proper consumption of the grass growth, good as well as bad; (*d*) that with salt, they get more thirsty and naturally drank oftener; (*e*) old animals were found licking salt oftener than the young animals.

*Effect of salt on vegetation.*—Since there was not an incessant attack on the good grasses only, they grew and seeded better, and thus helped further re-vegetation of the area.

*Cost of salt.*—According to the market (Poona) rate at 12 pounds per rupee, salting per animal per month costs two annas and ten pies.

In brief, with the use of salt more feed to cattle is made available on the grazing area, and thus the problem of adequate supply of fodder is partially solved.

## Summary.

1. The giving of salt to animals on grazing areas is a novelty in Western India. Grazing animals, however, get salt in slight quantity by licking rock, soil, ash and body of other animals.

2. Rock salt is convenient for grazing animals, since it is in compact crystalline mass and little hygroscopic.

3. Animals consume more salt during stall-feeding than open-grazing. They consume more when feeding on poor dry grass than on green succulent growth.

4. Salt is relished with great avidity by all bovines, who forget the habit of licking rock, soil, ash and body of other animals.

5. Salt facilitates easy control of animals and proper utilization of the growth.

## References.

Talbot and Chapline (1926). *Texas Agric. Expt. Station Circular 379.*

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# PASTURE RESEARCH.

## RECENT PASTURE RESEARCH IN GREAT BRITAIN.

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The complaint has often been heard in the past that grassland farming has scarcely received the same amount of attention at the hands of the scientific worker as has the subject of arable farming, despite the fact that the production of meat and milk has always figured so prominently in British farming. Be that as it may, the complaint can hardly be made with justice at the present time. The pioneer work of such well-known grassland investigators as Somerville, Gilchrist, Hall, Russell and Armstrong has been followed up and extended during the present decade in a series of investigations which have been prosecuted at certain centres for agricultural teaching and research throughout Great Britain. Curiously enough, this epoch of grassland research has coincided with a tendency on the farmer's part to restrict somewhat his interest in corn growing in favour of grassland husbandry, a change of policy which has, however been dictated purely by economic considerations.

In citing the various lines of recent agricultural research, one need only refer to the investigations into the mineral composition of the herbage from different types of grassland (Rowett Research Institute, Aberdeen); the studies of the pasture attributes of the individual species of grasses (Welsh Plant-Breeding Institute, Aberdeen); the work in connection with the composition, digestibility and nutritive value of pasture herbage under different systems of grazing (School of Agriculture, Cambridge). The important investigations of Imperial Chemical Industries, Ltd., into the questions of sectional grazing and the fertilizing of pastures should also receive special mention at this point. It is perhaps too early to forecast the ultimate effect on grassland husbandry of all the information which is steadily being accumulated in these different investigations, although it has already become apparent that present methods are by no means adapted to securing the fullest possible advantages which both pasture and meadow are capable of yielding. It will be surprising if the next few years do not witness a number of fundamental innovations in the methods of grassland husbandry throughout the Empire.

### COMPOSITION AND NUTRITIVE VALUE OF PASTURE HERBAGE.

The problem of securing information concerning the feeding value of pasture herbage under conditions resembling those of grazing was attacked at Cambridge in the following manner. At the beginning of the 1925 season, a large plot was marked out on one of the pastures of the University Farm. This main plot was further divided into seven equal sub-plots, and every day throughout the grazing season, one sub-plot was cut over by means of a 16-inch motor lawn mower. In this way the whole plot was cut over once per week throughout the season. After cutting, the grass was left as short as it might be left after being grazed by sheep under conditions of heavy stocking.

It should be noted, therefore, that in this initial trial the system of cutting was frequent and severe. The conditions were so designed as to bring out the results which would be obtained in respect of the composition and nutritive value under a system of uniform and close-grazing. In subsequent trials, the interval between successive cuttings was lengthened to a fortnight, 3 weeks, and so on, and the influence of these more lenient systems of cutting on the yield, composition and feeding value of the herbage was investigated.

The results of the 1925 investigation may briefly be summarised as follows: pasture grass kept short by efficient grazing contains a very high percentage of protein *throughout the whole season.* Roughly one quarter of the dry substance in such herbage consists of protein, an amount 2½ times as great as that found in grass which has been allowed to grow unchecked for hay. On the other hand, the amount of fibre in such young pasture grass is very much smaller than that in meadow hay. In respect of digestibility, young leafy pasturage compares favourably with a concentrate like linseed cake, being superior to that of a concentrate like palm kernel cake and very much superior to that of best quality meadow hay. Even the fibrous constituent, which in hay is often woody and of low digestibility, is, in pasture grass, digested to an extent almost equal to that of the carbohydrate fraction.

The Cambridge feeding trials have demonstrated that pasture grass possesses a far higher nutritive value than has hitherto been suspected. In its young leafy condition, its dry food material partakes of the character of a protein concentrate like linseed cake and not of a coarse fodder like hay. Unlike many farm concentrates, it is capable of supplying all the animal's requirements for vitamins and for bone and milk-forming minerals like lime, potash and phosphate. It was not without reason, therefore, that the conclusion was drawn "that the farmer's cheapest, and possibly his best concentrate is to be found growing within reach of the homestead". Young leafy pasturage is essentially a feeding stuff designed for production rather than for maintenance purposes.

It is customary to assume that the nutritive value of pasture, and its content of protein, are relatively low in summer and autumn, but this statement is certainly not in accord with the results of the Cambridge work. The feeding value was highest during the spring flush of grass and fell off slightly during mid-season as a consequence of the droughty conditions then prevailing. With the coming of rain, however, the nutritive value gradually recovered, until in September and October the grass was very little inferior in this respect to that available in spring. At this late stage of the season, the dry matter of the herbage contained no less than 28 per cent. of protein. This result is all the more interesting in view of the fact that the bulk of the herbage at the end of the season consisted of creeping bent, which is usually looked on as possessing poor feeding value.

There can be little doubt, therefore, that it is possible to maintain the nutritive value of pasturage throughout the entire season provided the herbage is adequately grazed. If, as is commonly the case, the pasture is only scantily grazed during late summer, then grasses like bent grass will grow mature and fibrous and of greatly diminished feeding value. The occasional use of the mower is to be recommended, where it is found impossible, by grazing alone, to keep the pasture herbage young and leafy.

In a second investigation carried out during the season of 1926 it was demonstrated that the richness of pasture grass in respect of digestible protein and starch equivalent, is under a system of close-grazing, independent of the botanical character of the herbage or the presence of little or much wild clover in the pasture. This is a finding of the most fundamental significance. It is difficult to resist the conclusion that the botanical composition of a pasture is of secondary importance, and that management, involving not only efficient stocking and close-grazing, but also adequate manuring to ensure density of herbage and vigour of growth, is the primary factor determining the nutritive value of pastures. Botanically, it is desirable that a pasture should contain a number of different species of grasses of different seasons of luxuriance in order to ensure a continuous succession of growths from early spring to late autumn. That factor complied with, it is merely necessary, in order to ensure the best results from the nutritional standpoint, to concentrate on preventing the grasses from flowering and seeding. Should the herbage be permitted to grow long and mature, as on poorly grazed pasture or under meadow conditions, there can be little doubt that the different species would display differing feeding values, and under such conditions the nutritive value would be likely to be conditioned by botanical composition. Under pasture conditions, however, it should be possible in large measure to overcome handicaps from the botanical standpoint by combining a system of close-grazing with an intelligent system of fertilising.

### ROTATIONAL OR SECTIONAL GRAZING OF PASTURES.

It is easier to achieve the object of close-grazing with small rather than with big pastures and for that reason there is a strong movement among British graziers in the direction of dividing up the extensive poorly-grazed pastures into enclosures of much smaller dimensions. The following brief outline of an experiment carried out during 1926 in Yorkshire under the auspices of Imperial Chemical Industries, Ltd., may be taken as typical of the experiences of farmers who have adopted the practice of the rotational grazing of pastures combined with intensive fertilising.

Two large pastures comprising 27 acres were divided into 6 paddocks varying in size from 4 to 5 acres each, with water laid on. In the previous December, the whole of the grassland received a suitable dressing of chalk, phosphate and potash. At the beginning of February, the first enclosure received sulphate of ammonia at the rate of 1 cwt. per acre, and at intervals of about a fortnight similar amounts of this nitrogenous fertiliser were applied in turn to the other enclosures. When the herbage on the first field was 4 to 5 inches long, a suitable head of stock was moved on to it for some days until the field was grazed *uniformly close*. The animals were then moved on to the second field, the first being harrowed and rested for a time.

In this manner the fields were grazed in rotation, the animals feeding on a succession of grass flushes of high nutritive value. After the cycle was complete, the procedure was recommenced, sulphate of ammonia being again applied at intervals to the plots to ensure a succession of flushes of grass. By the application of these arable methods to grassland, it is claimed that not only do the stock secure the herbage in a young and highly nutritious condition, but that the carrying capacity of a pasture may be doubled or even trebled. As a result of the early application of nitrogen, the grass makes sufficient growth for the stock to be turned out by the middle of March, this 'early bite' leading to a considerable reduction in the expenditure on concentrated foods.

The use of nitrogenous fertilisers on pastures provides the farmer with a method for converting a cheap form of nitrogen into valuable and highly digestible protein. The processes which occur during the growth of the grass, however, demand that the herbage should be held in check by efficient grazing if its high feeding value is to be retained. The intensive production of grass by the aid of fertilisers requires, therefore, the possession of a sufficient head of stock to keep the pastures closely and uniformly grazed. Unfortunately, many farmers at the present time lack the capital for purchasing the extra stock required for this purpose. The alternative, however, is to carry on with the usual number of animals and to reserve the surplus grass for cutting at periodic intervals, such mown grass to be preserved for winter feeding as a source of digestible protein.

### CONSERVATION OF THE PRODUCE OF PASTURES.

With the recognition of the protein-concentrated character of young leaf pasturage, it was but natural that suggestions should be put forward for the conservation of the surplus produce of pastures for feeding during winter as a protein concentrate. When publishing the results of the earlier Cambridge trials, the writer ventured to make the following prediction: 'A future generation may witness the utilisation of large areas of grassland for the sole purpose of production of protein concentrate. Pastures, having the appearance of vast lawns, may be cut over regularly and frequently throughout the growing season, the nutritious, protein-rich produce being preserved for feeding to animals in winter confinement, along with balancing home-grown feeding stuffs like meadow hay, cereals and roots. The mode of preservation may either be artificial drying, followed by pressing into cakes or grinding to the roughly powdered form, or it may consist in ensiling the freshly cut grass'.

During the 1927 season, Imperial Chemical Industries, Ltd., collaborating with the School of Agriculture, undertook the systematic cutting of some acres of grassland in the vicinity of their factory at Billingham. The cutting was so regulated that the herbage was always taken in its young leafy condition. Soon after cutting the grass was dried down in steam-heated troughs, and later the dried product was compressed into cakes by hydraulic presses. These dried grass cakes measured 6 inches by 5 inches by 1 inch, and were of such a density that 40 cubic feet of the compressed material weighed 1 ton. They had kept the green colour of the fresh grass and had a pleasant fragrant smell. They contained 8 per cent. moisture and 25 per cent. of protein. When moistened with water, they swelled up considerably and disintegrated. Sheep, bullocks and dairy cows ate them eagerly, both in their dry and soaked conditions. It is of interest to record that samples of these dried grass cakes have been kept for more than 2 years in an open box under laboratory conditions without displaying any deterioration whatsoever in respect of colour and smell. Their moisture content is still in the neighbourhood of 8 per cent.

Critical feeding tests on these dried grass cakes were made at Cambridge, and two main conclusions were drawn: (1) The process of drying does not in any way impair the high nutritive properties of the fresh grass. (2) The dried grass cakes can successfully replace oil cakes in the winter rations of dairy cows and fattening bullocks. It is permissible to hope, therefore, that dried grass cakes will shortly find their way on to the agricultural market and be used as a substitute for oil cakes in the winter rations of farm animals. The problem of devising suitable appliances for cutting and drying down young grass is being studied by Imperial Chemical Industries, Ltd., who are looking forward to placing the process on a commercial footing during the season of 1930.

The advantages of such a side-line in grassland husbandry are manifold: (1) Dried grass cake is an almost ideal concentrated food for farm stock. It is highly digestible and is rich in protein, lime, potash, phosphate, vitamins and plant pigments. Pasture grass conservation implies a 12, instead of a 5 months' pasture season. (2) On the basis of the 1928 winter prices, 1 ton of dried grass cake would be worth £9 15*s*. for its feeding value alone. It would also have a high manurial value of about 27*s*. per ton, compared with linseed cake at 31*s*. and maize meal at 11*s*. per ton. (3) The advantages of such a system of grass conservation during war time are so obvious as to need no emphasis. During the Great War, one of the most acute problems was to find protein concentrates for farm animals. This difficulty need never arise again, since now it is recognised that the farmer's best protein-concentrated food can be grown on his own farm. Further, the system enables the cuttings from playing fields and sports fields to be usefully conserved. (4) Grass conservation should prove an incalculable boon to droughty parts of the Empire like Australia, where the herbage shrivels away to nothing during bad seasons, and thousands of sheep perish miserably. Why should not the irrigation areas of Australia be used for the intensive growth of young grass to be continually dried and pressed into cakes for transport to the less fortunate droughty regions? Grass cakes will keep for years and are an ideal form for storage and transport. The day may be envisaged when they will be transported between colony and colony and favoured regions will produce them for transport to the more needy parts of the Empire. (5) By grass conservation it will be possible to augment very considerably the available supplies of concentrated feeding stuffs, the shortage of which at present not only prevents the attainment of an all-round standard of intensive animal husbandry in Great Britain, but also causes the high prices ruling for oil cakes and cereal foods.

It is clear that the artificial drying of young grass must always remain an industrial, or semi-industrial process. For that reason, the method of ensilage is likely to make a more direct appeal to the farmer. It is of interest to record that satisfactory tests have been carried out in this connection at Cambridge. Three small silos were filled respectively with grass cuttings from certain college playing fields; with a mixture of grass cuttings and dried sugar beet pulp; with a mixture of grass cuttings and oat straw chaff. The results were satisfactory in every case, the silage being readily eaten by stock. This side of the problem of grass conservation, however, is being studied further at the present time.

### The Yield of Pastures.

A third investigation carried out at Cambridge during 1927 showed that the differences in chemical composition, both organic and inorganic, between grass cut at weekly and fortnightly intervals are inconsiderable. The dry matter of grass grown

under a system of fortnightly cutting is a protein concentrate equal in digestibility and nutritive value to that obtained by weekly cutting. Moreover, by systematic cutting at fortnightly intervals, these characteristics are retained over the entire season.

During the season of 1928, the work was carried a stage further by the adoption of a system of cutting at intervals of 3 weeks. Though the herbage obtained under this more lenient system of cutting was somewhat less rich in digestible protein, it was nevertheless equal in respect of digestibility and nutritive value to grass grown under systems of weekly or fortnightly cutting. At the end of three weeks' unchecked growth, pasture grass still consists of non-lignified, highly digestible tissue as at the end of a week's or of a fortnight's growth. Although the protein content of the grass shows a slight falling off during the third week of growth, this is unaccompanied by any corresponding diminution in digestibility. It was further demonstrated that the depressing influence of drought on the protein content and digestibility of pasture grass is much less marked under a system of 3-weekly cutting than under the severer system of cutting every week.

During the carrying out of the 1927 investigation, it was found that if adjoining plots on a pasture be cut at weekly and fortnightly intervals respectively, then the plot cut fortnightly yields somewhat more heavily than the plot cut every week. Further, this disparity in productivity becomes most marked at those times of the season when the conditions for growth are most unfavourable, as, for instance during a spell of droughty weather. Since the weather conditions of 1928 were, on the whole, unfavourable to the abundant growth of herbage on pasture (owing to droughty conditions which prevailed during April, July and September), it would be anticipated that the yields from the plots submitted respectively to weekly, fortnightly and 3-weekly systems of cutting would display unusually striking differences. That this was actually the case is made clear by the accompanying table, in which a comparison is given of the total yields of herbage, in dry matter per acre, which were obtained in 1928 from the respective pasture plots. The yields from the same pasture under the conditions of the 1925 and 1927 investigations are also given.

*Summary of total yields from pasture plot in three different seasons of experiment.*

| 13th April to beginning of October. | Dry matter per acre lb. | Dry matter per acre lb. | Dry matter per acre lb. |
|---|---|---|---|
| | 1925 | 1927 | 1928 |
| Weekly cutting . . . . . . | 2,833 | .... | 1,982 |
| Fortnightly cutting . . . . . . | .... | 3,621 | 2,562 |
| Three-weekly „ . . . . . . | .... | .... | 3,216 |

It will be noted that under the weather conditions of the grazing season of 1928, cutting at fortnightly intervals produced 29·3 per cent. more dry matter than was obtained under a system of weekly cuts, whilst the yield obtained by cutting at 3-weekly intervals was 62·3 per cent. greater than that obtained by weekly cutting and 25·5 per cent. greater than that grown under a fortnightly cutting system. Since there is little or no difference, from the standpoint of starch equivalent, between pasture herbage grown under systems of weekly, fortnightly and 3-weekly cuts, the *yield* differences under the 3 systems are possessed of great practical significance. A system of weekly cutting is comparable with the system of grazing where it is the custom of the grazier to regulate the stocking of his sheep-grazing land in such a manner as to keep the herbage uniformly grazed down throughout the grass season. If the herbage shows any tendency to grow beyond the very young stage, more sheep are introduced to hold it in check. This practice may be referred to, for convenience, as 'non-rotational close grazing'. On the other hand, a system of 3-weekly cuts may be taken as conforming with the conditions of rotational grazing, where the interval between successive close-grazing of enclosures is of 3 weeks' duration. It will be convenient, for the purposes of the present discussion, to refer to such a system as a '3 weeks' rotational close-grazing system.'

The yield results bring to light an important advantage which 'rotational close-grazing' possesses over a system of 'non-rotational close-grazing'. If the pasture, on which these investigations have been carried out, had been so stocked during 1928 that the herbage was kept closely and uniformly grazed down throughout the season, then it would have produced herbage, for the sustenance of the animals, at the rate of about 1,980-lb. of dry matter per acre over the season. If, on the other hand, the tract of grass has been divided up into smaller areas in such a way that each enclosure, after being closely grazed by stock, was permitted a 3-weeks' interval of unchecked growth before being grazed down again, the pasture would have produced herbage at the rate of 3,220-lb. of dry matter per acre over the season. In other words, the stock-carrying capacity of such *unfertilised* pasture would have been increased in the ratio of 198 : 322 (*i.e.*, roughly 2 : 3). This measure of improvement naturally applied only to the pasture under investigation, under the weather conditions of 1928, and would probably not be so marked in a season more favourable to the abundant growth of herbage. Obviously, the question of the maximum yield of digestible food from a pasture is bound up with the investigation of the process of lignification in the herbage, since it is reasonable to assume that the conditions for such maximum yield will be realised when the intervals between successive cuttings, or grazings, is as long as possible. The length of this interval will naturally depend on the time required by the young

shoots of grass to reach the stage of growth at which lignification, with consequent running-off of digestibility, sets in.

The yield data possess further practical significance in relation to the proposals which have been put forward for conserving pasture herbage. Before adopting such proposals, it would be necessary to decide the frequency with which the grass should be cut during the growing season. From the standpoints of digestibility and starch equivalent, it is immaterial whether the herbage is cut at weekly, fortnightly or 3-weekly intervals. Under the 3-weekly system, however, the season's yield of herbage will be greater than will be obtained by cutting at shorter intervals, and the difference will be accentuated during seasons when the conditions are not favourable to growth of grass. In regard to protein content, the average figure, on the dry matter basis, for weekly-cut grass will be about 25 per cent., that for fortnightly-cut grass about 23·5 per cent., and that for 3-weekly-cut grass about 21 per cent. It is hoped to secure similar information concerning grass cut at monthly intervals during the 1929 season.

The data from these investigations also serve to demonstrate the *primary* importance of the influence of the general weather conditions of the season (in particular, those of rainfall) on the growth of pasturage. Within the limits of the systems of cutting which have so far been investigated, it is clear that unfavourable meteorological conditions in a particular season may lead not merely to a much smaller growth of grass than would be obtained, under the same system of cutting, in a more favourable year, but may actually cause the yield under a lenient system of cutting to the smaller, instead of larger, than under a less lenient system of cutting during a more favourable season.

## Supplementary Feeding on Pastures.

Certain very important consequences follow from the richness of young pasture grass in respect of digestible protein. Under conditions of intensive grazing, pasture herbage constitutes an unbalanced food for all classes of live-stock, not only for fattening animals, but also for classes of stock which make considerable demands for digestible protein in their rations, namely, young growing stock and dairy cattle. One or two examples will serve to make this point clear.

A ration of young spring grass containing 30-lb. of dry matter (that is, the amount of dry matter usually assumed to be the measure of the appetite of a 12 cwt. dairy cow) will supply, on the basis of the Cambridge figures, sufficient digestible protein to satisfy the requirements of a dairy animal yielding as much as 9 gallons of milk per day.

It may be assumed that the ideal ration for a young animal going out on to pasture will be one which approximates most closely to milk in respect of nutritive ratio and lime-phosphate ratio. The Cambridge results show that such a ration is obtained when 9 parts of fresh young pasture herbage are mixed with 1 part by weight of maize meal.

A fattening sheep of about 120-lb. live weight requires no more than ¼ lb. of digestible protein in its daily ration. Such an animal, when grazing freely on young spring pasturage will consume rather less than 4-lb. of dry matter per day, including, according to the Cambridge data, about $\frac{4}{5}$ lb. of digestible protein. In other words, the animal is receiving more than three times the amount of digestible protein requisite for its maintenance and production purposes.

It follows, therefore, that the time-honoured practice of using linseed cake, cotton cake or other protein concentrates as supplementary food for pasturing stock is not in accord with the results of the Cambridge investigations. On well-managed pasture, animals should receive, as supplementary food, feeding stuffs which are rich in carbohydrate and poor in protein, such as maize, flaked maize, maize germ cubes, barley, wheat, locust bean meal, sugar beet pulp, meadow hay, etc. Indeed, it appears justifiable to conclude that the optimum results are not possible on closely grazed pasturage with any class of stock, young growing stock, dairy cattle and fattening animals alike, unless such animals are receiving, at all stages of the season some supplementary food which is richer in carbohydrate.

## Minerals in Pastures.

The Cambridge investigations have amply demonstrated that young leafy pasturage is capable, in itself, of supplying the requirements of farm animals for bone and milk-forming minerals. In dealing with the problems of the nutrition of animals on *cultivated* pastures, the question of mineral deficiency can rarely arise. With the exception of milk, no feeding stuff on the farm is better balanced in respect of minerals than pasture grass. There are, however, vast tracts of *uncultivated* pasture in the British Isles and throughout the Empire where this statement is by no means true. Our knowledge of the occurrence of mineral deficiency in the herbage of such wide-spread pastoral areas has been brought together in a recent publication ("Minerals in Pastures", J. B. Orr, 1929, H. K. Lewis & Co., Ltd., London). This treatise is primarily the outcome of the deliberations of a sub-committee appointed in 1926 by the Civil Research Committee of the Cabinet to consider and report on the relationship between the mineral content of pastures and their nutritive value. From the initial enquiries instituted by the sub-committee, it was evident that malnutrition in cattle and sheep arising from deficiency of mineral in

grass was quite common in many pastoral districts of the Empire, and that the subject, which was of great economic significance, warranted close and systematic investigation.

A report to this effect was duly forwarded to the Civil Research Committee, on whose further recommendation grants were made by the Empire Marketing Board in aid of a comprehensive scheme of investigations into the mineral aspects of pastures, within the Empire. A twofold scheme of work was adopted, actual investigations in selected grassland areas being supplemented by a detailed search of the literature dealing with every phase of the subject. Major Elliot states in the preface to the volume: "At the request of the sub-committee the information so far obtained has been brought together by Dr. Orr in the present review, with the object of having it circulated to various officials and research workers throughout the Empire who are interested in the subject".

Beginning with an explanation of the economic importance of grassland, the author passes on to trace the development of scientific methods for investigating the problems of pastures. This is followed by a minute survey of the results of many investigations into the mineral composition of both good and poor pastures in the British Isles and in various parts of the world. The factors which affect the mineral content of pastures are also considered in the light of present knowledge. Dr. Orr then proceeds to deal with various forms of disease which are attributable to deficiency of minerals in pasture herbage. The deficiency diseases of grazing animals in Europe, Africa, Australasia, America and Asia are described in separate chapters, and the results of investigations into the causes of such diseases are summarised and critically discussed. A further chapter treats of the prevention of deficiency diseases of pasturing stock, either by the direct administration to the animal of the deficient minerals or by the enrichment of the pastures through the application of mineral fertilisers to the soil. It is shown that the prevention of disease by these measures also leads to an increased rate of growth in animals and to an increased production in adult females.

The question may be raised, however, as to whether the failure of animals to thrive on these deficient pastoral areas may not frequently be due as much to the *energy-deficient* character of the herbage as to its deficiency in minerals. The starch value of such herbage may be so low that animals, even when consuming it to the limit of appetite, may not be able to secure sufficient *net* energy to permit of normal development. This aspect of the problem is being investigated at Cambridge at the present time.

# PATHOLOGICAL CONDITIONS ASCRIBED TO NEMATODES IN POULTRY.

BY

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## INTRODUCTION.

The pathological significance of species of nematodes occurring in domestic birds has been emphasized to a considerable extent, but in most instances the subject has been regarded from the point of view of a particular parasite and its specific pathogenecity. It seems worth while to look at the problem from the opposite point of view, with the pathological condition as a primary consideration, and to assemble the individual reports of specific action of nematodes according to the effect produced. In this manner one may gain an idea of the variety of deleterious effects which have been ascribed to the presence of nematodes, and of the species of nematodes which have been reported as associated with such conditions. Upon finding a pathological condition in a domestic bird one may then be better able to judge of the possibility of its being of parasitic origin.

## STRIKING CLINICAL SYMPTOMS.

Certain clinical symptoms or other external ante-mortem changes have been described as caused by nematodes, the most important of which are given in the following paragraphs :—

### *Injury to Eyes.*

Injury to the eyes of domestic fowls is by its nature one of the most striking and most easily discernible of these conditions. Inflammation of varying intensity, at times so severe as to cause blindness and in some cases even complete destruction of the eyeball, may result from infestation with Manson's eye worm, *Oxyspirura mansoni* in the chicken. Similar damage is produced by *Oxyspirura parvovum*, the species found in chickens in Australia. Kobayashi (9)* has made a microscopical

* Numbers in parenthesis refer to "Literature cited", p. 448

study of the pathology of *Oxyspirura mansoni* and finds that the papillæ and follicles on the nictitating membrane, are remarkably increased, pathological changes being present which are somewhat similar to those seen in trachoma. An eye symptom of a different sort is the loss of pigmentation of the iris of pigeons, which has been noted as one of the most marked features associated with severe infestations with *Dispharynx spiralis*, which is located in the glandular stomach.

### *Respiratory Changes.*

Change in the rate of breathing in fowls is also an easily noted condition. Dyspnea and finally asphyxiation result directly from the presence of gapeworms in the trachea and bronchi; *Syngamus trachea* may cause such symptoms in chickens, pheasants, and quail, resulting in the death of the birds; a similar effect is produced in domestic geese and domestic ducks by *Cyathostoma bronchialis*. In addition, this clinical effect is said to result indirectly from infestation of the crop of ducks with *Capillaria contorta*, the distended crop compressing the pneumogastric nerve, with interference of breathing and resulting asphyxiation. Difficult breathing is also described as a symptom of infestation of the gizzard of geese and ducks with *Amidostomum anseris*.

## CLINICAL EFFECTS OF A CHRONIC NATURE.

### *Cachexia, anemia, and general toxic effects.*

Cachexia, including emaciation, anemia, and general toxic effects, has been described as caused by a considerable number of nematodes. As regards gapeworms, *Syngamus trachea* chiefly in chickens and pheasants, and occasionally in the turkey, and *Cyathostoma* in domestic geese and ducks, are said to have this effect. Worm infestations of the upper digestive tract, as *Capillaria annulata* in the esophagus of turkeys and chickens, and *Capilaria contorta* in the esophagus of ducks, and also infestations of the stomach, as with *Dispharynx spiralis*, *Streptocara pectinifera*, and *Cheilospirura hamulosa* in chickens, and *Amidostomum anseris* in domestic geese and ducks react similarly on the health of the bird. Intestinal worms, as *Hartertia gallinarum* in the chicken; species of Ascaridia, as *Amidostomum columbæ* in the pigeon, and *Amidostomum lineata* in the chicken, and species of *Capillaria*, as *Capillaria retusa* in the chicken, and *Capillaria columbæ* in the pigeon and chicken, have also been reported as producing this condition.

### *Paralysis or Marked Inco-ordination.*

Symptoms of paralysis and marked inco-ordination are reported as associated with *Capillaria contorta* in the duck, and with *Capillaria retusa* and *Ascaridia galli*

in the chicken ; in the last case the paresis in one outbreak, reported by Rovis (12), completely clearing up when large numbers of *Ascaridia galli* were removed by treatment. Drooping wings and ruffled feathers, with increasing weakness which gives the appearance of paralysis, are described by Ackert and Herrick (3) in chicks experimentally parasitized with *Ascardia lineata*, these symptoms being caused by loss of blood, impaired appetite, and a decided retardation of mascular and osteological development.

### *Effects on Appetite.*

The appetite is said not to be affected by *Streptocara pectinifera* in chickens ; it is described as greatly increased by *Dispharynx nasuta* in chickens. and by *Dispharynx spiralis* in chickens and pigeons, the birds eating ravenously up to the time of their deaths. On the other hand, loss of appetite is observed in connection with infestations with the eye worm, *Oxyspirura mansoni* ; with gapeworms, *Syngamus trachea* and *Cyathostoma bronchialis* with *Ascaridia lineata* of chickens and *Ascaridia columbæ* of pigeons ; with capillarids of the crop, *Cyathostoma contorta* of ducks and *Cyathostoma annulata* of chickens and turkeys ; and with stomach worms, *Tetrameres fissispina* of ducks and chikens, and *Amidostomum anseris* of ducks and geese. In *Ascaridia lineata* infestations, the appetites of the chicks, which during the early stage of the disease, are greatly reduced, later become voracious if the chicks survive.

### *Diarrhœa.*

Diarrhœa is said to result from *Tetrameres fissispina* in the glandular stomach of ducks and chickens, the food not disgesting, and an excess of bile, the secretion of which is stimulated, producing a greenish diarrhœa ; in addition, diarrhœa in chickens may be caused by *Heterakis gallinæ* and by *Strongyloides avium* in the ceca.

## PATHOLOGICAL CHANGES DUE TO NEMATODES.

Pathological changes which are revealed at postmortem examination are of varied nature and include the following :—

### *Inflammation of Digestive Tract.*

In the esophagus, both dilated and undilated portions, local lesions in the form of burrows, surrounded by areas of slight inflammation, may be caused by *Gongylonema ingluvicola* in chickens, by *Capillaria annulata* in chickens, turkeys, and quail, and by *Capillaria contorta* in ducks ; in the case of capillarid infestations the inflammation may become very severe with thickening of the wall as the mucosa

becomes catarrhal and later croupous, with sloughing off of the membrane. In the glandular stomach a catarrhal condition with thickening of the wall may be caused by *Dispharynx spiralis* in chickens and pigeons; by *Dispharynx nasuta*, *Tetrameres fissispina* and *Tetrameres americana* in chickens; and by *Amidostomum anseris* and *Echinuria uncinata* in domestic waterfowl. The lining of the gizzard may be destroyed and the muscular wall invaded by *Amidostomum anseris* in water birds, and by *Cheilospirura hamulosa* and *Streptocara pectinifera* in chickens.

An enteritis, at times severe, may be caused by species of Capillaria (*Cheilospirura meleagris-gallopavo* and *Cheilospirura retusa* in chickens and turkeys, *Cheilospirura columbæ* in chickens and pigeons, and *Cheilospirura collare* in chickens); by species of Ascaridia (*Amidostomum galli* and *Amidostomum lineata* in chickens, and *Amidostomum columbæ* in pigeons); and by *Hartertia gallinarum* in chickens, all in the small intestine. Severe and sometimes fatal cases of typhlitis are reported as caused by *Heterakis gallinæ* and *Strongyloides avium* in chickens. In the majority, if not in all, of these parasitic infestations of the digestive tract there is more or less tissue invasion at some time in the life history. The immature forms of *Ascaridia lineata* have been shown by Ackert to bury their heads deeply in the intestinal wall, with resultant destruction of the intestinal glands from the tenth to the seventeenth day after the infection is acquired by the chick, the worms thereafter withdrawing to the lumen. *Heterakis gallinæ* invades the mucosa of the ceca in a similar manner in the early stages. In other cases, as with *Strongyloides avium* in the ceca, with species of Capillaria in the small intestine, and with *Dispharynx spirali* in the glandular stomach, the adults are to be found in close association with the mucosa, although not actually burrowing to the extent that the species of Capillaria in the esophagus or the species of gizzard worms burrow in the wall.

*Nodule or Tumour Formation.*

Invasion of the wall of the digestive tract may lead to the formation of nodules or tumours. The larvæ of *Heterakis beramporia* were found by Schwartz (12) in the Philippines to cause a nodular disease of the ceca; both larvæ and adults of *Heterakis isolonche* act similarly in pheasants.

Bedel (6) has reported verminous nodules in the liver and intestinal walls in connection with *Ascaridia columbæ* in the pigeon. Itagaki (8) describes a severe nodular disease of the intestines of chickens which is of comparatively common occurrence in Japan in winter and mid-summer, and is caused by the larvæ of what he calls *A. perspicillum* (probably *A. lineata* or *A. galli*) which penetrate the wall of the intestine during those seasons that are considered adverse for parasitic development; in spring and autumn the larvæ do not penetrate the wall. In

waterfowl more pronounced nodules, or in severe cases actual tumours are produced in the esophagus and stomachs by *Echinuria jugadornaia* by *E. uncinata*, by *Hystrichis tricolor*, and by *Eustrongylides mergorum*. An increased tendency to the formation of neoplasms has been noted by Baker and his co-workers (5) in chickens which have survived the acute stage of infestations with *A. lineata* and *H. gallinæ*.

*Stenosis (constriction).*

Stenosis may follow from severe inflammatory reactions or from nodules or tumours in the walls of the digestive tract, and the nematodes previously listed as associated with such conditions may, therefore, be the cause of stenosis.

*Impaction or Occlusion.*

Impaction or occlusion may result from the presence of parasitic nematodes. Occlusion of the bronchi and trachea of chickens may be caused by *Syngamus trachea*, and of waterfowl by *Cyathostoma bronchialis*. The nasal passages of chickens may be occluded by *Oxyspirura mansoni*. This nematode is sometimes present in large numbers, Niles (cited by Ransom, 10) having seen as many as 200 worms in one chicken in Florida. Intestinal impaction may be caused in chickens by *Ascaridia lineata* or by *A. galli* instances of heavy infestations being comparatively common, and in pigeons by *A. columbæ*, of which up to 500 specimens have been found in one bird.

*Rupture.*

Rupture of an organ as a result of the presence of nematodes has been described with reference to the gizzards of chickens parasitized with *Cheilospirura hamulosa*. Le Roux (11) states that this nematode, which was present in more than 50 per cent. of the chickens examined by him in South Africa, may weaken the wall to such an extent as to cause it to rupture, with ultimate formation of a sac. The sac, gradually filling with ingesta forced into it by the muscular contractions of the gizzard, may finally occupy the whole of the abdomen.

*Hemorrhage and other Damage to Circulatory System.*

Hemorrhage is an additional damage which may be caused by nematodes. During the period of the invasion of the intestinal wall by the young forms of *Ascaridia lineata*, Ackert and Herrick (3) found evidence of blood in the feces. Punctiform hemorrhages of the intestine of pigeons are found in cases of *A. columbæ* infestation. In chickens, *Capillaria collare*, and in turkeys, *C. meleagris-gallopavo* are reported as causing small hemorrhages of the intestine. Specimens of *Ornithostrongylus quadriradiatus* when collected from the intestine of the pigeon are bright red from the ingestion of blood, and the intestinal contents of the bird

contain abundant erythrocytes. Evidence of hemorrhage is clearly present in *Amidostomum anseris* infestations of waterfowl, the necrotic tissue of the walls of the upper digestive tract, especially of the gizzard, being stained with blood pigment.

The cardio-vascular system has been shown to be affected by infestations with nematodes. Baker and his co-workers (5) report marked distention of the vessels of the parenchymatous organs and a noticeable enlargement of the heart in connection with experimentally produced cases of *Ascaridia lineata* and *Heterakis gallinæ* in chickens.

*Obscure Physiological Changes.*

Changes of a more obscure nature, which may be caused by nematodes, include injury to the thymus gland, which Ackert (2) has noted in connection with *Ascaridia lineata*, the gland in infected chickens of 2 to 3 months of age averaging less than half the weight of the gland in uninfected chickens of the same age. Reduction of the sugar content of the blood is another highly significant change which has been noted by Ackert and Titus (4) as accompanying infestation with this nematode.

A deposit of urates in the ureters and in and upon the pericardium and myocardium also may result from *Ascaridia lineata* and *Heterakis gallinæ* infestations.

*Secondary Infections as Results of Nematode Activity.*

Lastly, nematodes may make possible other infections in poultry. Worms which injure the intestinal tract may open the way for *Bacillus coli*, definite evidence of which was obtained in the study of the disease known as strongylosis, caused by *Trichostrongylus pergracilis* in grouse in England. In cases in which large numbers of the nematodes were present in the ceca, with chronic inflammation of the walls, *B. coli* was demonstrable in the liver, lungs, and other organs. The damage to the lungs caused by gapeworms in chickens and water birds may incite secondary infections resulting in pneumonia. The Oklahoma Agricultural Experiment Station (7) has reported a fatal pneumonia as resulting from large numbers of larvæ of *Ascaridia lineata* in chickens, but as other workers have failed to find migration of such larvæ from the intestine, the case appears to have been exceptional and requires confirmation. Introduction of another parasite by a species of nematode is illustrated by the transmission of the organisms of blackhead through the eggs, of the cecum worm, *Heterakis gallinæ*, of poultry.

SUMMARY.

A brief review of the instances of reported pathogenicity of the nematodes of poultry indicates a wide range of pathological conditions which may result from such parasitism. Gross examination of living birds may show the eyes directly or

indirectly affected by parasitic nematodes ; clinical symptoms of internal parasitism include dyspnea and asphyxiation, a chronic condition of cachexia, emaciation, or retardation of growth, and anemia, deranged appetite, diarrhœa, and paralysis or muscular inco-ordination. Pathological changes which have been observed include inflammation of the various parts of the digestive tract, formation of nodules or of tumours, stenosis, impaction or occlusion, rupture, production of hemorrhages, changes in the cardio-vascular system, deposit of urates, injury to the thymus gland, reduction of sugar content of the blood, and the facilitating of the entry of other infections. The species of nematodes which are reported as causing these conditions represent various taxonomic groups, so there is no evidence that a pathological significance is restricted to any one group. Critical study, such as Ackert and his co-workers have given to *Ascaridia lineata*, with the effects of experimentally produced infestation compared with control, that is, non-parasitized cases, is highly desirable in order that the subject may be further clarified.

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# ABSTRACTS

**On the Nature of the Reactions responsible for Soil Acidity—Part I. On the Titration Curves of Acid Clay.** JNANENDRANATH MUKHERJEE and HIRENDRA KUMAR SEN. (*Indian J. of Agric. Sc.* 1. 189,

The concept of a colloidal acid as usually formulated (cp. Bradfield (1923), *J. Am. Chem. Soc.*, 45, 1243, 2669) appears to suffer from some limitations common to theories which treat colloids as ordinary electrolytes. The implications of such theories have been briefly referred to and the difficulties in interpreting the titration curves of systems in which the interface takes part have been investigated with reference to some simple systems. Titration curves of saturated solutions of cinnamic, isophthalic and p-toluic acids both in presence and absence of excess of the solid phase and for different times of interaction with the alkali have been given. Titration curves of aluminium hydroxide soils are also given. The part played by traces of electrolytes in their behaviour and in interpretation of titration curves have been pointed out. [J. M. and H. K. S.]

**Statistical Studies in Indian Dairy Cattle, I. Standardisation of Lactation period milk records.** LAL CHAND SIKKA. (*Ind. J. Vet. Science and Animal Husbandry*, 1, 63.)

1. The problems of Indian dairy cattle are highly complex and their solution bristles with difficulties. Measured by European standards, Indian dairy cattle are no doubt inefficient and uneconomical, but they possess qualities which make them unquestionably the best tropical cattle in the world, and the best way of solving the Indian cattle problem is to improve them without sacrificing their desirable qualities. The most hopeful line of their improvement is to establish, maintain, and breed herds of the best Indian breeds, and eliminate from them by selection and rejection all cattle below a fixed standard.

2. The process of selection, however, is by no means simple. To select for milk production for instance, one has to know the true milking capabilities of the animals. This means the "standardisation" of their milk yields to a common basis by eliminating from them the effect of varying environmental factors like season of the year, service period, age, and dry period, which affect them. A statistical study of the milk record of the pure Indian (Sahiwal) and cross-bred cows maintained by Government, Military and other dairy farms was conducted to study the effect of first three of these environmental factors on the lactation-milk yield of a cow.

3. Taking normal lactation period milk records, the following results were obtained :—

(*i*) Pure-bred Sahiwals calve at intervals of about 13½ months, of which they are dry for 120 days. Thus about 30 per cent. of their life is useless. This is very high as compared with the dry period of foreign cows which is only half as much.

(*ii*) Due probably to the excellent system of herd management, the season of the year does not seem to have any great effect on total lactation yields.

*iii*) Service period is a very potent factor in determining the lactation yield, as it effects the length of the lactation. A short one decreases it and a long one increases it.

(*iv*) Regarding age, the lactation milk yield at first increases at a decreasing rate with the increase of age till the age of maximum productivity, and thereafter it decreases at an increasing rate with advance in age.

(*v*) For pure-bred Sahiwals the actual age of maximum yield is roughly 3rd-4th lactation period, as against the 6th for foreign ones and 8th for Pusa cross-breds.

(*vi*) Whereas foreign cows and Pusa cross-breds show an increase of 30-40 per cent. in the milk yield over the first lactation yield up to the age of maximum productivity, the *best average* pure-bred Indians increase only by 10 per cent. approximately.

4. The investigation can not be considered to be final, but it proves the poor milking qualities of Indian cows and the highly efficient nature of cross-breds as milk producers. Whether the immediate solution of the urban milk-supply problem rests with pure Indian breeds or cross-breds is too obvious to be emphasised. [L. C. S.]

**Practical Feeding Tables for Dairy Cattle in India.** CAPTAIN C. E. MACGUCKIN.

(*Ind. J. of Vet. Sc. and Animal Husbandry*, **1**, 124.)

These tables are designed to meet the many changing factors in feeding dairy cattle in India, with the minimum amount of calculation. They are based on the assumption that in normal feeding practice the most consistent factor is the concentrate mixture. The quantity of concentrate mixture to feed has therefore been worked out in a series of tables to compensate for the other variables not so easily controlled. [C. E. M.]

**Sericulture in Iraq.** D. D. PATERSON. (*Dept. Agri. Iraq Memoir No. 14*, 1930)

Silk-rearing has been practised in Iraq for many years, but the industry has declined very greatly within recent years. With the idea of re-establishing it on more modern lines research work in sericulture was entrusted to the Agricultural Department, Iraq, in 1922.

Experiments to discover the most suitable variety of silkworms for Iraq were started at Baquba, where two dozen varieties were tested for the purpose from 1922 to 1925. The experiments were not a success, largely due to the lack of proper rearing accommodation and equipment. Consequently in September 1925 an efficient Silk Research Station was established at Rustam.

Inbreeding experiments with the local silkworm strains were started in 1926, but had ultimately to be abandoned as an unfruitful line of research. Experiments with imported varieties of silkworms were also undertaken, and as a result of four years' work "Baghdad White," a strain imported from Marseilles, was found to be the best for rearing in different Liwas of Iraq. The local strains proved to be definitely inferior to many of the imported varieties.

Careful records as to dates of hatching, number of feeds, length of life-cycle and of quantity and quality tests of the different varieties experimented with have been kept for comparative purposes.

The incidence of silkworm diseases at Rustam has been, for all practical purposes, eradicated. The percentage of diseased worms in the districts has also been reduced.

It has been proved profitable to export cocoons for reeling to other countries provided the quality of cocoons sent is reasonably good. It has also been shown that rearing, reeling and weaving are profitable operations provided they are carried out locally, and there is a normal market demand for the produce.

Weaving experiments at Rustam showed that it was possible to weave various marketable types of silk cloth on the local hand-loom, and suitable grades of cloth for the modern market in Baghdad were also recommended.

Comparative tests with the different available strains of mulberry trees proved the ***Narinji Khafif*** Abyadh (Male) variety to be most suitable for silk rearing. An orchard of an early leafing type of mulberry tree was also planted, and it served as a useful source of cuttings for distribution to the Liwas.

It is evident from the annual increase in the number of packets of eggs used that increased interest is being taken in sericulture in all quarters of Iraq.

Some useful suggestions for future development of sericulture in Iraq are also included.

**Economic Benefits of eradicating Tuberculosis from Livestock.** JOHN R. MOHLER, A. E. WIGHT AND L. B. ERNEST. (*U. S. Dept. of Agric. Mis. Pubn. No. 66.*)

The following are the authors' conclusions and summary :—

The economic benefits of tuberculin eradication presented briefly in the foregoing pages, may be summarized further as follows :—

The systematic campaign to eradicate tuberculosis from livestock has an important practical bearing on the value of animals, their salability, and on profitable outlets for livestock and dairy products.

Although an insidious disease of high morbidity tuberculosis can be entirely eradicated from individual premises and from large areas by systematic tuberculin testing. Even extensive infection can be eradicated by repeated tests, and the removal of reactors.

The extent of tuberculosis among cattle has been materially reduced during the progress of the eradication as evidenced by both meat-inspection records and official surveys. The degree of reduction cannot be determined definitely by post-mortem figures since large numbers of reactors are included in the federally inspected kill. When such reactors are left out of consideration, a decline of more than 50 per cent. in condemnations is indicated. The results of surveys since 1922 indicate a reduction of about 50 per cent. in tuberculosis among cattle throughout the country.

The total quantity of beef condemned by Federal inspectors because of tuberculosis has averaged over 20,000,000 pounds annually in recent years, but this loss is now declining.

The campaign to eradicate tuberculosis, including the removal and slaughter of more than 1,500,000 reactors, has had no adverse effect on the milk-supply of the United States. On the contrary, total production and per capita consumption of milk have increased materially.

The interstate shipment of cattle from tuberculosis-free areas has become an extensive business, average monthly shipments being about 45,000 head, intended principally for dairy and breeding purposes.

Tuberculin testing, especially when large numbers of cattle are involved, is inexpensive, the cost being repaid many times by subsequent economic benefits.

The number of cities and towns that require their milk supplies to come from tuberculin-tested cattle exceeds 1,500.

City milk ordinances containing tuberculin-test requirements bar the sale of unsafe milk and increase the demand for the product of tuberculin-tested cows.

The number of counties classed as modified accredited areas has been increasing steadily, with prospects for further increase until all counties in the United States have completed systematic tuberculosis eradication.

Records of the amounts which owners of tuberculous cattle receive for condemned animals, including salvage, Federal indemnity, and State indemnity, show that the owner's loss is usually less than a fourth of the animals appraised value. This loss is soon retrieved in the form of better prices for livestock and their products.

Approximately 12 per cent. of the swine slaughtered under Federal inspection show some evidence of tuberculosis, though the lesions are usually small. Though less than 2 per cent. of the carcasses of affected swine are condemned, the total present loss is approximately 16,000,000 pounds of pork products annually.

Tuberculosis of poultry is the cause of serious economic loss in the form of reduced egg production, unthriftiness of fowls, and their death. Data from 28 States indicate that about 7 per cent. of poultry flocks are infected to some extent by tuberculosis.

Cattle owners report that breeding stock from tuberculosis-free herds sell more readily and at better prices than similar animals from untested herds. Increases in value fluctuate considerably, the usual increased value ranging between $10 and $50 a head In some localities untested cattle are practically unsalable.

There is close agreement in the estimates of the increased value of tested cattle in reports received from livestock owners, county agents, veterinary inspectors, cattle buyers, and others closely in touch with cattle values.

The milk production of dairy herds from which tuberculous cattle are removed generally increases, owing to the replacement of reactors with better cattle and through increased attention to health, sanitation, and herd management.

The postponement of tuberculin testing generally causes losses greater than the income obtained from cattle that prove later to be tuberculous.

Tuberculin testing tends to broaden the outlet for livestock products from a farm, often resulting in new local industries and a saving in hauling and other marketing costs.

A very tangible benefit of systematic tuberculosis eradication is the payment of premiums, amounting to 10 cents a hundredweight, for tattooed, tuberculosis-free swine from modified accredited areas. This bonus is offered by many packers because of their desire to obtain healthy hogs. During 1926, 1927, and 1928 farmers in the Corn Belt and adjoining States received premiums aggregating over $2,000,000. In some areas the amount of premium money has frequently exceeded the entire cost of tuberculosis eradication.

Since livestock serves as the principal balance wheel in the agriculture of the United States by consuming a large proportion of our crop and forage resources, the health of such livestock is essential to our highest agricultural prosperity.

**Ensilage and the Pastures.** (*New Zealand J. of Agric.*, Vol. 41, No. 4, 1930.)

Attention was directed in these notes last month to the value of ensilage as a means not only of providing reserves of feed for use when fresh grass is in scant supply, but also of bringing about proper control of pasture-growth. Haymaking at times can be used for these same purposes, and some farmers ask why ensilage is being suggested as a preferable alternative to hay. Ensilage is often markedly more serviceable and suitable than haymaking, after making full allowance for the fact that it involves dealing with a much greater weight of material than does haymaking. Ensilage is superior to haymaking under many circumstances, primarily because it allows of surplus feed to be conserved when it should be conserved. This is because silage can be made irrespective of the weather conditions, which so often either delay haymaking or result in the loss or serious deterioration of the crop before it is saved as hay.

Conserving surplus growth when it should be done rather than when the weather permits it to be done is beneficial in three distinct ways. In the first place, the conserved material is of greater feeding value, in that there is no reason for it to be characterized by the excessive stemminess and consequent poor digestibility that characterizes much of the hay that is made. In the second place, the farmer is not forced to resort to the rush periods of work which are a feature of haymaking and which often lead to costly neglect of other important farm-work. In the third place, the pastures benefit in a dual manner when surplus growth is removed at the right time. No rank growth, with its consequent harmful opening up of the turf, develops, and a better and more reliable aftermath can be expected when the surplus growth is removed at an early stage. These are some of the important facts that make ensilage frequently preferable to haymaking. A further advantage is that it gives reserves of feed which are practically free from damage from vermin and from fire-risk.

In addition, ensilage can at times be resorted to in order to place in reserve crops that could be satisfactorily dealt with in no other manner. For instance, the first cut from a lucerne area ordinarily becomes available each season at a time when conditions are extremely unfavourable for haymaking, and when there is nothing to be gained by giving the stock green feed in addition to that which is obtainable from the fields under grazing. Often plants other than lucerne occur freely in the first growth of each season on an area devoted to lucerne. When this is the case it is much against good future yields from the lucerne to leave the growth unmown until good haymaking weather can be expected. The only satisfactory course is ensilage. In like manner growth containing heavy quantities of weeds, such as thistles, can at times be conserved in edible form as ensilage, whereas in the form of hay the stock would not consume it.

By adopting the practice of ensilage a farmer may build up reserves of feed which could, if necessary, be fed with satisfactory results in summer as well as in winter, whereas haymaking gives a reserve which generally cannot be so satisfactorily used at both seasons. When there are reasonable grounds for expecting that silage may be utilized for the feeding of stock when they are producing milk, then it is highly desirable that the silage be made from material cut at an immature stage before there has been much or any development of bloom. Silage made from stemmy, mature green material when fed to milking stock to supplement pastures may not be superior to hay—indeed, it may be inferior to hay well saved from material cut at an early stage.

From these merits of ensilage it is not to be concluded that ensilage should always necessarily be adopted to the exclusion of haymaking. Often, indeed, both silage and hay may well be made on the one farm: by making silage early in the season when broken weather is likely, and hay later on when good weather is likely, more surplus feed is conserved than could be done otherwise, and at the same time the labour of doing this well distributed so that no serious dislocation of farm-routine work occurs. Summed up, the intrinsic worth of ensilage comes from the facts that it can be practised irrespective of weather, and that herbage which cannot be used satisfactorily for hay can at times be better utilized for ensilage.

Some farmers refrain from ensilage on account of the belief that it is a somewhat difficult process with which to attain success. Actually it is not at all difficult. It is less difficult than much other farm-work which is generally undertaken without hesitation; it probably calls for less skill than haymaking under average conditions. All this is rather well illustrated by the method of making the winning stack in last season's extensive Taranaki ensilage competitions. According to the report of the judge, Mr. J. M. Smith, "the crop was cut while the herbage was in a young growing condition. The material came in straight from the mower, and the stack was built to a height of 8 ft. the first day. Building was continued and completed the following day when the stack went to a height of 15 ft. and a covering of 15 in. of soil was put on straight away. The stack was 21 ft. square. It cannot be held that there is anything intricate about such a practice. A detailed account of ensilage-making is given in Bulletin 146 of this (New Zealand) Department.

Ensilage does not tax the labour resources of the ordinary farm if suitable modern equipment is used. Three to four workers will make really good progress with equipment which can be purchased for from £40 to £50, and which also serves excellently for haymaking. Where a suitable site for a pit is available only a portion of the expenditure just mentioned will suffice under many circumstances, and in numbers of cases a team of two workers has efficiently saved silage.

From the dependable field evidence contained in the separate article appearing in this issue (New Zealand J. of Agric. Vol. 41, No. 4) it will be clear that there are grounds for the belief that ultimately ensilage will be of the great value to our sheep-farming that it is already to our dairying. Proper pasture utilization is the sphere in which many farmers show most scope for improvement. What the governor is in the working of the engine, that is ensilage in the utilizing of pastures --control.

The smaller the amount of silage saved the greater is the proportion of waste. Hence it sometimes becomes advisable to ensile together material from several sources. For instance, in the early part of the season by conserving together surplus material from pastures, from green cereals, and from lucerne, many farmers would have a much more satisfactory bulk of material to work with than would be the case were each crop treated separately.

**Some Economic Factors in Poultry Husbandry.** A. W. ASHBY. (*Harper Adams Utility Poultry Journal*, Vol. XV, No. 12, 1929-30.)

During the last 25 years poultry husbandry in Great Britain has made very great progress. Stocks of fowls have increased very rapidly, supplies of eggs and poultry have increased, and yet prices have been well maintained. There has been great progress in technical methods of breeding and selecting stocks, in feeding, and in general treatment on a large number of specialised holdings and some general farms, but we shall overlook one of the most important factors if we attribute the increase in stocks and supplies wholly to progress in technical methods. Some changes on the side of consumption are quite as important as those in methods of production. The consumers have been willing to take all the increased products, and in the case of eggs they have been willing to pay good prices for good quality supplies. Poultry keepers have been fortunate in having this expanding market. With increasing supplies most agricultural producers have to look forward to falling prices, both actual and in relation to prices or other products. Poultry keepers have been able to increase supplies and yet obtain relatively high prices.

The expanding market for good quality eggs seems to be symptomatic of trends in consumption. Consumers are looking for the lighter of the meat types of foodstuffs, and in spite of industrial depression there are classes of consumers who are willing to pay the prices necessary to secure what they want. So far as can be judged the market for eggs, more or less for poultry, and for others of the lighter meat products, is likely to expand still further. With improved economic and industrial conditions we can look for an increased demand for good quality eggs and poultry.

But the egg market needs the protective attention of producers. The greatest danger to this market is the continued existence of what may be called the "barn-door poultry flock." These flocks produce irregularly, their owners still pay little attention to quality and cleanliness of supplies, and it is important to realise that nearly 80 per cent. of British eggs still come from general farms and small holdings. Probably we shall not be far wrong if we say that 75 per cent. come from non-specialised poultry holdings, and over 50 per cent. from what may still be called the barn-door flocks. In Wales we estimate that 55 per cent. of the eggs come from such flocks.

On many farms the domestic fowl has been and still is regarded as a waste-user or as a scavenger. There are many people who still believe that profits are made while the flock consists of 50 to 100 hens which get half their food for themselves, and that there is likely to be less profit if the flock is

increased or methods are changed so that birds require more food and labour. The barn-door hen does get about half its own food. With consumption at 90 to 100 lbs. per year under farm conditions (allowance has to be made for dirty feeding ground and loss of grain) the barn-door hen receives about 50-60 lbs. of food in the year. Production per hen varies between about 50 and 80 eggs, and in Wales we estimate the average at 75 eggs per year. On this basis there is a superficial case to be made out for the barn-door flock. The saving of 50 lbs. of food at *4s.* or *4s. 6d.* must be set against, say, 50 eggs; or when labour and other charges are included, the increases in cost incurred in better management are *4s.* to *4s. 6d.* for food, a shilling for labour, and a shilling for capital and depreciation, which brings extra costs to *6s.* or *6s. 6d.*; and against this has to be set a yield of 50 to 70 eggs. The conclusion of the calculation with supporters of the barn-door flocks is that it is better to leave them as they are.

But it may be suggested that the better poultry keepers are now carrying the barn-door flocks on their shoulders One can scarcely imagine what would be the state of the industry and the markets if they were left to those who pursue the easy and haphazard methods of handling poultry. Supplies would fluctuate violently. Imports would have a free field for four or nearly six months of the year. Consumers would not be tempted to ask for home-produced eggs, and would have reason for turning to imported supplies. As there is every reason to believe that general improvement in supplies of eggs, including regularity of presentation, would lead to increase on the existing demand, there is ample reason for a campaign for getting rid of the remaining barn-door flocks, and for improving all methods of the general farmers who have not hitherto given much attention to their flocks.

The seasonality of the production of eggs still needs attention. So far as can be discovered the delivery of fresh eggs from British farms shows greater variation between the Spring flush and the Autumn shortage than in the years before the War. It is difficult to see any reason for this change, but it may be that the spread of the lighter breeds with a higher yield capacity to farms on which they live roughly may lead to a higher production during the flush months without any higher production during the months of bad weather. In any case, seasonal variations in prices in 1924-1928 were greater than in the years 1910-1914. Imports of eggs in shell are much more regular than supplies of British farm eggs, and imported supplies are relatively heavy from September to the end of the year. Some of the early winter imports are cold-stored, others are small, cheap eggs. The latter can be distinguished in statistics, and the former cannot, but there is reason to believe that imports of really fresh eggs are more regular than British supplies. The autumn and early winter peak in prices, especially of British fresh eggs, tends to restrict purchases by some consumers, and to move demand of others from British to imported supplies. But some consumers who would "buy British" can scarcely secure supplies. When demand is moved from British to near European rather than to cold-stored or to Egyptian and Chinese supplies the competition is the more dangerous. Big variations in prices tend both to move demand and to restrict it. In the increase and improvement of supplies seasonal distribution is an important item.

As regards production, poultry keepers have recently been favoured by relatively low prices of foodstuffs. Purchases in retail quantities do not always show the changes that occur in the producers' or the wholesale markets, yet foodstuffs have been cheap. As foods represent some 60 per cent. of the total cost of flock maintenance this has been an important item in the economy of the business. Although some of us hope that last year's grain prices will not continue there are no present prospects of very high food costs. One of the main points here is to see that some of the newer foodstuffs now recommended by experts are purchasable and purchased at fair prices.

The fundamental problems of poultry husbandry have been and are biological and biochemical. The questions of breed and strain, period of hatching, feeding, housing and hygiene, and control of

disease are all important. But I would make a plea for the work of the economist in respect of poultry husbandry, for important economic questions are arising in production. We ought to have more information than is now available on such subjects as these: Cost of feed in relation to total egg production; and in relation to seasonal production. Cost of feed in relation to value of eggs, both according to number and according to price as determined by seasonal production. The cost of labour and equipment in relation to size of flock. Cost of hatching *versus* buying chicks, cost of hatching and rearing, or buying chicks and rearing *versus* buying pullets, and the general results of these various methods of maintaining flocks under different circumstances. Next to feed, labour is the most important item in costs, and we know very little about the economy of use of labour with poultry flocks.

There is, however, one question which I should like to raise which I am sure will create discussion. At the present time it appears to me that the general farmer will find greater probability of profits at a yield of 120 eggs per bird (average calculated on total number of pullets and hens started in autumn) than at 150 or a higher yield. I now speak primarily from Welsh experience, and the corresponding figure for England may be a little higher than 120. But there is some danger in striving for higher yields, especially if this is done mainly on the basis of breed or strain. In seeking higher yields equal emphasis ought to be put upon breed and strain, on culling, on feeding, on housing and hygiene, and care ought to be taken to secure stock that can stand high yields in the harder conditions which they encounter on the general farm. While we must seek higher yields, partly for the advantage of better seasonal distribution of supplies and partly for general economy in production, we must take care not to press yield beyond the optimum point for the general farms. Whatever the optimum figure may be for the specialist poultry farmer, the figure for the general farmer is still quite low. Raising the average to 120 in Wales would require an increase of one-third or thereabouts; and one-third rise in England would only raise the average to about 135 eggs per bird. We cannot expect such increases by changing the stock alone without incurring some other risks Progress towards higher yields must be of the all-round character of stock selection and management.

We may look to poultry husbandry to make as much progress in the near future as it has made in the past. But if stocks and supplies increase it will be necessary to cultivate the markets by every possible means. Profitable poultry keeping will depend on the further development of the market, and to this both production and marking arrangements must make their contributions.

### Agricultural Co-operation in the Irish Free State. (*Int. Rev. of Agric., Pt. II, Monthly Bull. of Agric. Economics and Sociology*, Vol. XXI, No. 12, December 1930.)

The Irish Free State (usually described in official documents under its Gaelic designation, *Saorstat Eireann*) consists of twenty-six out of the thirty-two counties which constitute Ireland. It contains 17,019,154 acres of land and has a population of 2,971,992 persons, of whom 1,307,662 are described as "occupied persons, 12 years and over". Of these, 523,025 are designated as "farmers and relatives assisting", and 139;104 are accredited to "other agricultural occupation", making a total of 672,129 working either at the cultivation of the land, as farmer-owners, gardeners, etc., or aiding those who do so. The high proportion of land workers (over 22 per cent. of the inhabitants, over 51 per cent. of occupied persons and nearly 78 per cent. of a larger group into which occupied persons are subdivided, "producers, makers and repairers") gives to agriculture its great predominance over other callings in a country where the absence of mineral wealth, save to a very slight extent, greatly reduces the industrial possibilities. To maintain its population at or near the existing figure, it is therefore necessary to export a considerable proportion of agricultural produce and of the by-products of agriculture. Of these—whether for export

or for home consumption—much the more important groups are live-stock and live-stock products, which, in the last official returns on the "Agricultural Output of Saorstat Eireann" (1926-27), are valued at £50,555,000, as against £8,264,000 for total crops and £5,938,000 for turf ("peat"); making £64,757,000 in all. In this (the live-stock) group, milk products hold a most important place, being valued at £13,693,000, while "cattle slaughtered in or exported from Saorstat Eireann" are put at £13,809,000. It should perhaps be explained that the figures in this return do not include any part of the produce which was used for further agricultural production, whether that part was used on the farm or sold from one farmer to another within the area of the State.

In Ireland, for many years, dairying has mainly meant butter production. Unlike England, where urban areas absorb a large proportion of the milk supplies, the Irish Free State has few towns whose population rises above 20,000, and only two, Dublin and Cork, where the figures exceed 100,000; thus the whole milk, cream skim and butter-milk "consumed by persons or exported" are valued in the "Agricultural Output" at £354,300, whilst the whole milk sold to creameries mainly for manufacture into butter and the butter made on farms, were valued at £10,157,000; the total quantity of whole milk produced being estimated at 589,000,000 gallons, the quantity of butter made in creameries at 587,000 cwts. and the total butter produced at 1,491,000 cwts.

It should be added that creamery butter, which fetches higher prices than either "Factory" (*i.e.*, blended) butters or "farmer's butter" (home made), is a constantly growing proportion of the whole, and that cheese is not made in any appreciable quantity in the Irish Free State. To see the relations of creamery butter making to the country as a whole in better perspective, it will be necessary to consult the export figures. The latest published are for the first ten months of 1930 which give the export as 365,665 cwts. valued at £2,345,361 as against 376,947 cwts. valued at £3,092,072 for the corresponding months of 1929. During 1930 Irish butter in consonance with all butters marketed in Great Britain (to which country only it is exported) fell considerably in price when compared with 1929—a serious loss to Irish dairy men and explicable partly as a reaction from the general agricultural slump and perhaps more directly as the result of unemployment and general business depression in the English cities. The other butters exported during the period were "factory" 109,371 cwts. at £648,768 and "farmer's" 2,041 cwts. at £13,785. The full figures for 1930 will almost certainly exhibit a further decline in values.

The exports for the two full calendar years, 1928 and 1929, have also been published and these show that the quantity of creamery butter exported in 1929 was 426,279 cwts. and the value £3,512,805, whilst the corresponding figures for 1928 were 405,834 cwts. and £3,368,437 respectively. The total exports of all butters for these two respective years were 560,482 cwts. valued at £4,554,855 and 539,124 cwts. valued at £4,536,321. As the total value of the exports of all kinds for the same year (1929) were £46,803,448, it will be seen that butter alone constitutes nearly one-tenth of the exports of the State.

Two other facts about Irish farming may serve to make the conditions under which the co-operative movement, and more particularly co-operative dairying, is carried on clear to the reader; Irish farming is small farming and the average farmer is a very poor man. The latest date at which the measurements of holdings were available was 1917, but there is no reason to assume that any proportional changes of importance have since occurred, though, during the "boom" years following the close of the war, a good many farmers extended their acreage by purchase. (On the whole, such extensions seem rather to have added to farmers' burdens than to have improved their financial condition and in some districts, at least, newly acquired land has been left derelict and in others the purchase of small holdings by "landless" men has tended to keep the average low.) In 1917 the number of holdings under 30 acres was 310,824 out of a total of 443,406. In England farms of 100 acres and under are reckoned as "small" farms, and taking that as a dividing line, the Irish count for

1917 would be 413,534, or about 90 per cent. of the whole. Partly because of this, the remuneration to the workers in agriculture (mainly farmers, agricultural labourers being only occasionally and only seasonally employed on the smaller farms) is very low. The Agricultural Output computes it as about £88 per person occupied, or, allowing between one and two persons to each farm (frequently the farmer has the help of one relative), the income is little if anything above that computed for the industrial worker whose average is £121 *per annum*—and this computation charges against the farm, at city prices, produce consumed there. It will readily be seen that, on the smallest farms, even the smallest economies in production and very small increments of profit are of great importance. That is one reason why co-operation is essential to it.

## 1.—The Beginnings of the Co-operative Movement.

When, in 1889, Irish economists, led by Sir Horace Plunkett, eager to check emigration, and to raise the status and income of small farmers (then beginning to acquire the ownership of their holdings under a series of Acts of the British Parliament which continued to be passed until the first decade of the Twentieth Century and were further extended and developed after the Irish Free State had begun to function in 1922), first made a study of the new agricultural economy in continental countries and especially in Denmark, the fact which emerged most clearly was the necessity for combined or co-operative activities in agricultural production, credit and sale. It was on production that these pioneers chiefly concentrated and in it, particularly in regard to dairying, that their most notable successes were achieved. The history of the movement, which must here be only glanced at in a few sentences, may be roughly divided into four periods—the decade which closed the Nineteenth Century, the pre-war period up to 1913, the period of war, unsettlement and new constitutional development, up to 1923, and the post-war period, with which this article is mainly concerned, and which may be regarded as covering 1923-30. No complete survey of all the facts for the first period (1889-1900) has been written, but its objectives and the results then achieved were sketched by Sir Horace Plunkett in *Ireland and The New Century*, which, aiming at propaganda, attained sufficient historical significance to make it indispensable to students. The last year of the Nineteenth Century showed that the organising body, the Irish Agricultural Organisation Society, had succeeded in forming several hundred societies, mainly creameries, whose butter sales were shown as £703,826, to which a general turnover of £327,781 has to be added and a small business in credit through credit societies, bringing the total up to £1,038,877.

Though polemical matters, which cannot be debated here, political, agrarian and cultural, divided the farmers' aims during the second period between economic advancement on co-operative lines and other objectives, and retarded the growth of the movement, there was a steady rise in the figures for business done, which by 1913 had risen to £3,333,189, of which butter sales represented £2,323,441, and general turnover £954,256, as before there was a business in loans through credit societies to add. The next decade, 1913-23, was one of war, revolution, disturbance and, finally, a political settlement ultimately acceptable to the majority and with it the formation of the now existing State. More disturbing financially, perhaps, than the incursion into agricultural areas of men in arms, were the reactions of the European war, the rationing and derationing in Britain of the war and post-war years, the short boom and the longer slump in agricultural prices, the incertitude of the future in the farmers' minds, and the changing vicissitudes of organisation amongst a population swiftly but only very moderately enriched and as swiftly impoverished and politically and, even more, economically unsettled, whose market in Great Britain had also lost its normal equilibrium. The movement's turnover rose from £3,668,958 in 1914 to £7,574 438 in 1917, again to £14,604,852 in 1920 and fell back to £7,725,072 in 1923, the last date for which the Irish Agricultural Organisation Society had figures until those (collected in the autumn of 1930) for 1929.

## 2.—The Irish Agricultural Organisation Society.

Before making comparisons between the figures which end the post-war period and the latest figures available, two digressions are necessary : brief explanation of the purposes, scope and constitution of the Irish Agricultural Organisation Society and of the types of society which it organises and accepts for affiliation. The Irish Agricultural Organisation Society was founded in 1894 after the co-operative pioneers were satisfied that their five years of initiating organisation had resulted in a movement of permanent value to Irish farmers. By that date 33 societies had been formed and, although the total sales of the creameries then working were only £151,852, there could be no doubt that the methods they were applying to agriculture were valuable and indeed necessary. These societies had modelled themselves on the Rochdale plan as regards capitalisation and finance on Danish co-operation in regard to dairying business and on Raiffeisen principles in respect of credit, but with minor modifications in each case. In founding a Society to act as guardian to societies already formed and to promote other societies, the founders, who had come together at the request of Sir (then Mr.) Horace Plunkett during a Parliamentary Recess and had issued a Report outlining their proposals, set themselves a task of no slight difficulty. Polemical issues, which cannot be discussed here, had made association between public men of varying parties and different creeds very difficult, the public mind was occupied by grave problems which have since passed into history and, above all, the new public service for which the nascent movement called required to be financed. Mr. Plunkett's purse was drawn on freely and later, when the Department of Agriculture was established, his salary, as its Vice-President, was yearly donated. This financial problem, the crux of the situation, did not find an altogether adequate solution but, in forming a Society which should both assist the societies promoted by it and receive a certain amount of financial support from them, the initiators planned a device which, novel at that time, has been copied or adapted elsewhere : by England in the Agricultural Organisation Society, whose fosterage of co-operation after many years of work was taken over by the National Farmers' Union ; in Scotland by the Scottish Agricultural Organisation Society ; in Wales by the Welsh Agricultural Organisation Society ; in Finland by Pellervo, and ultimately in Ireland itself, after partition, when the Ulster Agricultural Organisation Society took over that portion of the work (previously done by the Irish Agricultural Organisation Society) in the six counties politically designated as Northern Ireland. It is a notable evidence of the unifying influences of co-operation that the relations between co-operators in each State subsequent to partition remained mutually cordial, as, indeed, they had continued to be even whilst citizens on both sides of the Ulster border had taken to arms on opposite sides of Irish political controversies.

The financing of the Irish Agricultural Organisation Society has, throughout, been worked on the following lines : the State was requested to look upon the organisation of an agriculture based on associations formed for combination in production, distribution and sale, as a public service, to be assisted from Government funds but not dominated (as the civil service must necessarily be) by Parliament ; the societies themselves were expected to honour the principle of self-help by contributing to the upkeep of the parent body, and the public were offered an opportunity to aid a work of national importance and secure representation on the governing body by subscribing. The allocation of State funds in Ireland was a difficult matter to effect and it took time and work to wear down political opposition to the idea—time and work which if fate had allowed them to be put into the constructive business of building up the societies, would have brought swifter moral and financial success to co-operation. The policy as originally conceived in Ireland had involved recognition by the Government of expediency of "State aid for Self-help" but, although the Development and Road Improvement Funds Act had made specific provision for hypothecating public funds for the teaching of co-operation by organisations "not trading for profit", it was not until 1913 that the

first annual subvention under this scheme was paid to the Irish Agricultural Organisation Society. It continued from that date until the setting up of the Irish Free State in 1922, and the British Treasury continued to act yearly on the recommendations of the body charged with the duty of advising as to the allocation of such grants ("the Development Commission") itself and advisory committee of the Treasury. And, on the cessation of these grants, the Free State Government, having taken over as part of the financial settlement an agreed proportion of the Development Grant, continued the subvention to the Irish Agricultural Organisation Society and on an extended scale. (The present grant covers the period 1926-31 at £8,500 per annum.) The third source of revenue, public subscription, has for some years been a decreasing element in the income of the Society, which has, however, in the course of its career, drawn a good deal from personal contributions and has had public-spirited help from idealistic citizens. It has been supported by a considerable majority of its own societies, in varying degrees of generosity, but, on the whole, in reasonable proportion to their income. It is a rule in the constitution of each society formed that it shall contribute to the parent body on a scale agreed to by the General Meeting (the ultimate authority in all matters of policy) but, though this rule is legally binding on the constituent societies, the Irish Agricultural Organisation Society has never sought by legal injunction to enforce it on any recalcitrant society, so that in fact, though not in form, these subscriptions are voluntary. The funds from this source increased in 1930 in spite of agricultural depression.

The constitution of the Irish Agricultural Organisation Society, formed originally mainly on the model of the Co-operation Union of Manchester, has been modified in minor points from time to time and when, on the establishment of the Irish Free State, negotiations for a continuance of the Development Grant were entered into, the State made its acquiescence in that claim contingent on certain conditions, the chief of which was a change in the mode of electing the representatives of societies and other subscribers to the Committee—which roughly corresponds to a Board of Directors, but unpaid—as well as a general agreement between the State and the Society as to the scope and tenor of the work to be undertaken. No direct representation of the State was sought for, except during a brief period of transition, and thus no direct responsibility for the Society's activities is accepted by the Administration. These activities have been varied in their application to different branches of farming during the whole period of the Society's existence since 1894, but the main lines of the original scheme have been consistently followed. The scheme aimed at is the formation of regional self-governed societies under model rules which provide for capitalisation and the carrying out, under committees elected by the General Meeting, which is (under the law) the dominating authority, of definitely specified business purposes such as (*e.g.*) the manufacture and sale of dairy produce or bacon, the sale of agricultural produce, the purchase and re-sale of agricultural requisites and equipment or such other necessaries as the farm or the farmer requires, and the co-operative uses of credit. All these societies accept in their constitution the democratic vote (per person, not per share), a limitation by rule of the rate of interest (usually to 5 per cent.), a limitation in the shareholding interest held by any one member, open membership (to any applicant farmer within the area of the Society's operations but subject to the Committee's power of vote in individual cases) and, generally, the limitations laid down by British law in the Industrial and Provident Societies Acts or, in the case of credit societies, certain regulations laid down by the British Treasury, authorising the raising of loans from members and others to be re-lent (subject to the Societies' Borrowing Powers Act and to certain designated provisions of the Friendly Societies Acts) to members only, "for the purposes of agriculture, horticulture or arboriculture". All this enabling legislation has been taken over by the Irish Free State in continuance of British Acts, but not all of it is fully adapted to its purposes and so a new Co-operative Act is pending. Societies can also accept for membership other societies, thus enabling them to work upon the principle of federal sale or purchase, etc.

A short outline of the methods of the Irish Agricultural Organisation Society must suffice to complete this part of our survey. Where a neighbourhood small enough to be easily organised and large enough to contain the potentialities of lucrative business has become aroused, by contact with an organiser or by reading or through the initiative of local leaders, to the fact that the farmers could, if co-operatively organised, advance their financial interests by, for instance, carrying out dairying through a co-operative society or could effect economics in purchase through a credit society or a society for joint purchase, the proof of their recognition of the potential virtues of such an organisation will manifest itself through a sufficient amount of capital being subscribed. This gives the Irish Agricultural Organisation Society which will first have satisfied itself that the projected enterprise in the existing conditions has a fair prospect of success—reason to believe that the local farmers may be registered as a society and, registration under the Act having been arranged for, the organiser sees them through the first phases of their existence. The legal forms of incorporation are signed; a business committee is elected, the financial conditions essential to enable them to function are carried out, usually through a joint stock bank, with or without an advance from the State which, but only in certain contingencies, lends this form of support. A site is chosen for a creamery or stores, buildings are erected, purchased, or rented, if necessary, plant is installed, a manager appointed and all minutiae incident to the starting of a new business are worked out. In most or all of these processes, the Irish Agricultural Organisation Society is called on to assist—often indeed to decide what is to be done. The Society, once launched as a going concern, is visited as often as funds, circumstances and local needs demand by officials of the Irish Agricultural Organisation Society, for business, accountancy and general purposes, and if the concern is a productive society, such as a creamery, by officials of the State Department of Agriculture to advise on technical questions and inspect and report in accordance with Governmental regulations.

### 3.—The movement in the period 1923-29.

The period whose comparative figures we are about to consider, 1923-29, was one of re-integration. Grave political unsettlement characterised the earlier years of this septennial period, and constructive work of all kinds had been retarded for a decade earlier. It is clear proof therefore of the suitability of co-operative dairying to the agricultural conditions of Ireland to find that the sale of butter by the co-operative creameries rose from £4,659,462 in 1922 to £5,034,285 in 1923. There was, however, in 1923 a decline in the total turnover of the movement of over £1,200,000. This decline was mainly in general turnover, an apparent retrogression to be considered later. That year is the last for which statistics for co operation for all Ireland have been published. The new political developments involved partition between the six counties of "Northern Ireland" and the remainder of the island, and the formation of the Ulster Agricultural Organisation Society marked out a circumscribed area in each State, as the field of operations for State-aided co-operation. To obtain strictly comparable figures therefore, as between 1923 and 1929 for the Irish Free State, it is necessary to deduct from the totals for all Ireland the business done in the earlier year in counties Antrim Armagh, Down, Derry, Monaghan and Tyrone. Even when we have done this, the figures require to be used with some reserve. Not all of the returns furnished by the societies are vouched for, as, in a few cases, estimates have had to be accepted. Besides this, not every society, though each is under legal obligation to return its membership trade and other balance sheet figures to the Registrar, has in fact done so and the totals quoted below are, therefore, probably an underestimate of the business done in the years compared. Taking, then, the available returns for the trade done in the Irish Free State, in 1923, we can cite, as minimum figures for sales of butter and cream, £3,635,065; for agricultural goods sold through dairying societies (creameries) £282,257; for agricultural requisites sold by co-operative agricultural societies, £959,448; for sales of poultry and eggs through societies formed for that

purpose, £48,108; for bacon and meat (for three societies exclusively devoted to that business and, in particular, to bacon curing) £295,226, together with small "sundry" business £8,154; bringing up the total for the sales of local societies to £5,228,258. Two other figures complete the full turnover; the trading federations (the Irish Agricultural Wholesale Society and the Irish Co-operative Agency Society) did an aggregate business of £877,637 and there were loans advanced to farmers, through credit societies of £24,161. These figures make a grand total of £6,130,056. Owing to a variety of causes, the Irish Agricultural Organisation Society have no statistical data available for 1924-28, but in 1929 we find an increased total of sales: the local societies account for £7,929,674, the federations (at this date, the Irish Agricultural Wholesale Society and the Irish Associated Creameries) for £3,157,648 giving an aggregate for trading societies of £11,087,322 against £6,105,895 for 1923 and when the loans from credit societies, £86,234, are added, the grand total for 1929 reaches £11,173,576.

Some observations are necessary to account for the remarkable percentage increase thus reached—about 67—and some explanation of the items which made up the total. The principal source of increase is in the sales of butter and cream which rose in 1929 to £5,571,479, being more by nearly £800,000 than in 1923. So large an addition to the turnover of co-operative dairying societies (about 50 per cent.) is very remarkable in face of the fact that a considerably reduced price for butter was obtainable in the later of the two years; it implies a considerable "change over" from proprietary to co-operative ownership in the creameries of the country, which is in fact what occurred.

4.—The transfer of proprietary creameries to co-operative societies.

In the winter of 1926-27 it became known that the owners of the largest blocks of dairying property in the State were willing, if a purchase could be effected at terms they considered equitable, to sell out their creamery buildings and plan, equipment and other assets, including houses, condensing plant and buildings, etc., and to have the milk supplies they had previously handled transferred to farmer-owned and farmer-controlled societies. The proposal was readily entertained and energetically followed up by the Irish Agricultural Organisation Society, but it involved obvious financial difficulties. Farmers, many of them hitherto unorganised, could not easily at a stroke capitalise an undertaking so wide spread, covering large areas in the province of Munster, and requiring immediate conversion to a new system. Moreover, not all of the retiring proprietors' properties were suitable for being acquired by societies each of which was autonomously worked within a confined area. The Irish Agricultural Organisation Society, acting in the initial stages as an intermediary between the proprietors and the farmers, virtually all of whom were desirous of bringing the negotiations to a rapid and satisfactory conclusion, approached the Government, which, seeing in the proposed transfer a potential source of increased income to the dairy farmers (to whom, under the co-operative system, the full profits of the industry would, of course accrue) and, therefore, an added impetus to an important industry, moved in the Dail ("House of Commons") through the Minister for Agriculture, Mr. P. Hogan, whose declared policy has always included agricultural co-operation, for the financial and other powers necessary to implement the sales. The method adopted, with the ready support of the political Oppositions as well as of the Government supporters, was to authorise certain civil servants as representative of the State to register themselves as a company (the Dairy Disposal Co.) so as to procure the buildings, plant and other assets of the proprietors, to secure the milk supply and to re-sell the properties so acquired to existing or newly formed co-operative societies, under the aegis of the Irish Agricultural Organisation Societies; selling also, however, to private purchasers such properties as the farmers were unable or unwilling to take over or, alternatively, as a temporary measure, themselves to work such business (*e.g.*, condenseries) in the interests of the State (as purchaser) but not, of course, to the financial detriment of the milk suppliers. To enable the farmers to purchase, however, recourse to loan capital was

necessary and to secure the advances to which the Dail agreed it was necessary that the membership of the purchasing creameries should accept liability. This was agreed upon in advance of legislation and was made formally binding under the Creamery Act, 1928, which stipulated that each member should be liable for a £1 share for every three cows owned by him, and, so as to prevent any new competitor from weakening the financial standing of a borrowing creamery, enacted that no new creamery should be established within the area worked by a society contracting for a loan from the Department of Agriculture (the lending body) save with the consent of the Minister. Also, to bridge the gap between the agreed purchase price for all the properties and the amounts farmers' societies might reasonably be expected to pay as purchase money on their acquisitions of creamery buildings, plant and milk supply (condenseries and certain other properties not being necessary for their purposes as manufacturers of butter), the State should make itself responsible for the difference, a sum estimated not to exceed £95,000. These negotiations naturally took some time to work out. Although the conversion was rapidly accomplished in most cases, the Dairy Disposal Board is still in charge of part of the original property and also works such creameries as were not purchased by the milk suppliers in their vicinity or closed as "redundant" having regard to existing co-operatives, in the joint interest of the State as owners for the time being; and ultimately of the farmer-suppliers. The immediate result, as has been seen, is a considerable rise in the co-operative business of the State. Indeed, the 50 per cent. increase in butter sales does not fully represent the value of the conversion, seeing that trading transactions carried on by the Dairy Disposal Co., even where not yet co-operatised, cannot be regarded as "proprietary business" in the exact sense and that probably not more than 10 per cent. of the creamery output of the Irish Free State would now come properly under that designation.

### 5.—The Federations of Co-operative Societies.

It has been stated that the creamery output of the movement for 1929 is approximately 50 per cent. above that for 1923, but the aggregate trading figure 67 per cent. The difference does not arise from increases in the business of the other local societies but mainly in the output of the Federations and specifically that Society which handles the greater proportion of the butter produced in co-operative creameries. This feature of the situation demands comment. The older of the two federations, the Irish Agricultural Wholesale Society, has been 33 years in operation. Its principal objects, to purchase for the local societies, the supplies, and other requirements, seeds, manures and equipment of the farm, wholesale, redistribute them to its member-societies at "bed-rock" prices and so enable them to ensure for their membership the cheapest and most efficient service, are being steadily fulfilled, though the business done falls far short of the movement's potentialities. In Ireland, as elsewhere, loyalty to co-operative principle, the disciplined support of the local society by its members and of the Federations by their constituent societies, is still only in process of development. The business of the Irish Agricultural Wholesale Society does not cover nearly 100 per cent. of the societies purchases. In 1923 it was £353,351; in 1928, £597,481, in 1929, £592,178. The societies' support has increased in recent years; the figure for 1929 representing an increase in quantities over 1928.

The same co-operative principle which underlies the Irish Agricultural Wholesale Society is the basis of the creamery federation: joint sale of butter in the interests of the societies, through a common organisation and, with it, the elimination from the movement of inter-competition and under-cutting and sale "on consignment". There was a body formed so far back as 1893, aiming at these results, but it never covered an adequate proportion of the societies' trade. (This society, the Irish Co-operative Agency Society, is still in trade). Following on the transfer of the proprietary creameries, a bigger effort was instituted in the formation of the Irish Associated Creameries, which, during 1928-29, effected a business of £2,548,200 and £2,565,470, respectively. The method

adopted by this Society was to arrange for definite contracts between the local creameries, which financed it, and the Irish Associated Creameries. Under these, about 80 per cent. of the creameries sold over 60 per cent. of the butter manufactured in co-operatives. This included a very large percentage of their own aggregate turnover, in fact nearly all of it except small consignments for which provisional exclusion was made in the contracts. The ultimate result of this experiment is still uncertain. The fact that not all the creameries participated has left the market still subject to undercutting. "Free" creameries not merely remained outside and competed against the Federation but engaged in a press controversy opposing the course pursued by the adherents of federal sale. A more perturbing influence on the contracting creameries, most of which, despite difficult marketing, honoured their contracts, was the virtual collapse of prices in 1930 due to the pressure of the world market, to "over-production" (in the perhaps rather inexact use of that word), to "under consumption" (in relation to supply) and to unemployment in Great Britain. These factors effected even the price of Danish butter (an all-the-year-round product) but less than Irish (which is seasonal) or New Zealand or Australian. The conditions of the butter market and the consequent serious price reactions on Irish dairying have prompted the Government to appoint a commission "the Butter Marketing Tribunal", to collect evidence, examine the situation and report. Their Report is awaited as we write, and pending its appearance the situation cannot be more exhaustively analysed. Also, a collateral question is now being considered. The Tariff Commission, a body charged with investigating claims made by manufacturers for tariffs on their produce, has been requested to consider favourably a proposal of an important duty of four pence per lb. on butter Pending their examination of the evidence to be placed before them and their ultimate recommendation, they have requested the Government to anticipate and prevent forestalling, *i.e.*, flooding the market with imported produce, a practice almost inevitable where foreign producers foresee the possibility that a tariff wall may be erected against them. As an embargo is not provided for in administrative machinery and would involve legislation and delay, the Government, with the support of the Oppositions, have, as a temporary prohibitive measure, fixed a tariff of £5 per cwt on imported butter. But whether the Commission will ultimately recommend a permanent import duty cannot be foreseen. Should they not do so, the tariff now agreed upon will be cancelled, alternatively, it may be considerably reduced.

### 6.—Minor co-operative activities

It will be seen, then, that the increased turnover in sales for the co-operative movement in 1929 is due, firstly, to the new dairying areas brought within the co-operative system and, secondly, to the big business effected by Irish Associated Creameries. Certain minor increases in the business of other co-operative types enter into the respective aggregates of the years under observation. That for the Irish Agricultural Wholesale Society has already been dealt with. The creameries in 1923 sold, besides butter, goods mainly agricultural, value for £282,257 and the co-operative agricultural societies' total business is shewn as £959 448, a total for this class of trade of £1,241,705; whilst the similar figures for 1929 are £959,275 and £648,049, total £1,607,324. Sales of eggs other than those disposed of by co-operative poultry societies are to a small extent included in these figures and cannot be separately calculated. The percentage increase is, it will be noted, small. This is accounted for partly by general economic conditions and partly by the constant and unavoidable preoccupation of the Irish Agricultural Organisation Society with dairying, the branch of co-operative trading carried out under its aegis which is the most widespread, the most financially important and which makes relatively the least drain on its limited finances, as the dairying societies are able to pay in affiliation fees and subscriptions a considerable fraction of these costs of travelling, organising and inspection incurred by the parent Society in its fosterage of them. This the agricultural societies cannot do. There are other reasons, too, why those societies which aim rather at effecting economies for their

members in the costs of fertilisers, seeds, equipment and other necessaries than at adding directly (as do the creameries) to their cash income have had a more difficult and less lucrative career. Many of them were started in the war and earlier post-war years, when the costs of goods in rural areas had come to render the purchase of certain farming necessities almost prohibitive. Yielding to the pressure of farmers all over the country, the Irish Agricultural Organisation Society accepted for affiliation a larger number of societies than its limited and overworked staff found that it would adequately superintend. These societies, in many cases under-capitalised, aiming chiefly at keeping down retail prices in the small rural areas they attempted to cater for, were managed by young or inexperienced managers and by committees of farmers, some of whom had but little experience of business and perhaps less of co-operation. Moreover, the hurried manner of their organisation gave organisers insufficient opportunity to instil into the membership an understanding loyalty to and a direct insight into the principles of co-operation, neglect or ignorance of which always proves to be bad business as well as leading to a lack of co-operative discipline. The immediate effects of these societies on the position of farmers within their ambit were often significant and valuable: they brought prices down to a point at which farmers could satisfy their needs without exorbitant costs. But the competing retailers, realising that no other aim animated the rank and file of the membership than to buy cheaply and that so long as a co-operative society exists in an out-of-the-way place it becomes the price-fixer for the vicinity, often reduced their prices temporarily to or below the co-operative level. In such cases members, finding they could now purchase as cheaply from retailers as from the co-operative store, gave their orders to the local shops (some of them, perhaps, run by their own relatives, others having a "pull" over those of the society members who were in their debt) and by starving their own society of trade, of capital and of cash (due for goods brought on credit) brought about its demise. There were many liquidations, hastened probably by the general unsettlement of the postwar years and by the impossibility on the part of the Irish Agricultural Organisation Society of finding finances adequate to enable it to give societies the attention which this branch of co-operative effort required and would in time repay. At present the inspection of these societies is carried on by the Irish Agricultural Wholesale Society, and their importance is reflected in its balance sheets. But it is worth noting that, whilst as we have shown there has been a decline in their total trade, that deficiency is more than countered by the agricultural (as distinguished from the dairying) trade of the creameries so that on balance business of this character shows an increase of about 22 per cent. on 1929—a proportion whose significance will be better understood if it is remembered that the costs of living figures of the latter year were about 5 per cent. less than those of 1923, and the prices of goods retailed by these societies were also lower. There are other slight changes in the figures of these years; but the only one perhaps calling for comment is an increase for the societies (of which there are three) selling pig or meat products, or both, from £295,226 to £713,844. This increase is mainly due to the business of Irish Meat Ltd., an enterprise only recently doing an active business, which aims at securing for pig breeders in Munster and South East Leinster the best prices for bacon pigs (less, of course, cost of production and a small fixed interest on the capital supplied by the farmers themselves).

In all the productive societies under notice, of course the main ultimate gain is never the interest on capital, but always the return to the producer of the full value of his produce, whether directly in the price paid for raw material, or indirectly in the form a so-called "bonus" on trade, which may be looked upon as a distribution of profits to the producer in due proportion to the raw material supplied or—more exactly—since it is claimed that these are not profit-making business in the correct use of that term—a disbursement to the producer of the actual proceeds (less the costs of running and capitalising the business) obtained from manufacturing his milk into butter or his pigs into bacon. The Societies which are distributive as distinct from productive aim at procuring for him the materials of the farming industry at wholesale prices.

### 7.—THE TOTAL TURNOVER OF THE CO-OPERATIVE MOVEMENT.

All the trading now under review works out at £11,173,556 as against £6,105,895, or, if the sales of local societies only be included and those of the two federations omitted, there is then a business of £7,929,674 for 1929 and of £5,228,258 for 1923. It is on the latter computation that the figures here cited, though not fully inclusive, can be relied on to the extent, at least, of establishing a rough proportion between the value of the co-operative trading of these two years of five to three in favour of the later one. Another figure is needed to complete this brief survey. A few agricultural banks or credit societies are working over nearly the whole period of the movement's activities. One of the causes which prevented the co-operative agricultural societies from making further headway has been responsible for a slowing down of credit co-operation also: the inability of the propagandist body during times of economic stress to finance an activity indirectly economic but not directly money-bringing, *i.e.*, the organisation and inspection of societies neither actually trading nor directly affecting prices. Other causes also contributed: the fact that it is difficult to procure farming credits during an agricultural slump, the fact (on the other hand) that during the agricultural boom farmers did not need to borrow, lost interest in credit societies and allowed them to lapse. Two fillips have, however, been given to this important, if humble and slender, form of relief for small farmers in need of economic short term credits. The Government, finding it necessary to enable farmers to re-stock lands, denuded of their cattle and sheep by reason of fluke disease and similar causes (brought on by a succession of severe winters in 1925 and subsequent years) utilised existing and new credit societies for the granting of loans for the purchase of stock and similar purposes, the advances being on the basis of £2 for each £1 locally deposited in the credit society. (Subsequently, where owing to poverty or other causes the deposits were not forthcoming, the deposit proviso was waived). In the first classification the societies were allowed to borrow free of interest for three years, in the second (non-deposit societies) at 3 per cent. The advances were re-lent at 5 per cent up to a maximum loan per borrower of £50. Loans amounting to £84,795 in all were thus advanced and, in the view of the Department of Agriculture, with considerable benefit to thousands of farmers, thus enabled to "re-populate" their fields with cattle and sheep. These loans are in course of repayment. A latter development has been a scheme whereby creameries can borrow from the Agricultural Credit Corporation—a registered Company largely State-financed for making advances to farmers—sums to be advanced to members on the security of their milk, handled by the creameries for purposes of butter making, such advances to be a debt due from the dairying society (the nominal borrower) to the Corporation, after the society's committee (on the recommendation of an *ad hoc* sub-committee, which investigates applications for the loans) endorses the individual member's request. Including these loans, which are portion of the creameries' business, loans have been made to individual members by credit societies amounting to £86,234 in 1929 against £24,161 in 1923.

We are now in a position to sum up broadly the financial results for 1929. A grand total is reached for that year of £11,173,556 compared with £6,130, 056 for 1923. Neither total is absolutely inclusive of all the business done, but no omissions or revisions would affect these proportions appreciably, each of the totals cited being probably a few thousands below the actual net business done, if every society's turnover were known and available for inclusion. Only in two years, when costs of living were very high, has the movement had so large a turnover. These figures are a striking commentary on the importance to Irish farmers of agricultural co-operation. The very serious condition of farming everywhere precludes taking too optimistic a view of the near future and it would be scarcely reasonable to hope that the results of the year now drawing to an end will disclose equally satisfactory returns. Nevertheless the value to the Irish farmer of co-operative production, sale, purchase and credit remain unimpaired. Through it alone can he hope to obtain

reasonable control of his industry, reduce his working expenses by eliminating unnecessary middle costings, and place himself so far in command of the working of his industry as world conditions permit. It may be found that the severe drop in butter prices will seriously reduce the returns for Irish dairying for 1930, but the greater the financial strain to which the farmer is subjected, the greater is his need for the economies which the co-operative system places at his hand.

**Feeding Hevea rubber seed meal for milk production.**—W. B. Ellett, C. W. Holdaway, J. F. Ehbart, and L. D. Lasting. (*Virginia Stn. Tech. Bul. 41 (1930)*, pp. 12.)

To determine the value of Hevea rubber seed meal, a by-product from the processing of the kernels of the seed of the Para rubber tree, 2 groups of 2 cows each were fed by the reversal method. The basal ration for each group consisted of 20 lbs. of corn silage and 8 lbs. of alfalfa hay to which was added in one group 5 lbs. of Hevea rubber seed meal and in the other group 5 lbs. of linseed meal. The groups were fed in this manner through a 10-day preliminary and a 30-day milk production period, after which the rations were reversed for similar periods. While receiving the rubber seed meal, the cows produced 1,937·9 lbs. of milk and 73·06 lbs. of butterfat, and during the linseed meal period they produced 1,779·4 lbs. of milk and 71·4 lbs. of butterfat.

Digestibility trials with the same cows showed the following coefficients of digestibility for the components of Hevea rubber seed meal: Dry matter 51·5 per cent., crude protein 71·3, other extract 92·5, crude fibre 20 5 and nitrogen-free extract 58·1 per cent.

The results of this study indicate that Hevea rubber seed meal may be used as a medium protein concentrate in rations for dairy cows, that it is palatable, that it has no bad physiological effects, and that it is apparently equal to linseed meal for supporting milk production. [Reprinted from *Experiment Station Record*, Vol. 63, No. 6, October 1930.]

**A Study of Methods used in Washing and Sterilizing of Milking Machines and their comparative value.** (*Indian a Stn. Rpt. 1929.*)

Milking machines were successfully washed by sucking at least 1·5 gal. of cold water into the unit immediately after using. This was followed by sucking 1 gal. of hot water at a temperature of from 160 to 190° F. into the unit. This washing removed all the milk and heated the metal and rubber parts to a temperature sufficient to destory the majority of the bacteria. When the average air temperature was above 60° it was necessary to fill the teat cups and milk tubes with sodium hypochlorite at a strength of 200 parts per million. [Reprinted from *Experiment Station Record*, Vol. 63, No. 6, October 1930.]

**Ten Points in Better Breeding and Ten Points in Better Feeding of Cattle.**—The following is extracted from the *U. S. Department of Agriculture Leaflet No. 51* entitled "Improving Cattle in Areas Freed of Ticks", by John R. Mohlar:—

The following ten points in better breeding are essentials that should be kept in mind:

*Ten Points in Better Breeding.*

1. There is no best breed of livestock. There is more difference in earning power between individuals of the same breed than among breeds.

2. Select and raise the breed best adapted to your locality. Encourage your neighbours to do likewise, for community breeding has many advantages.

3. Use only pure-bred sires of good type and good blood lines.

4. Sell for slaughter or castrate all scrub, grade, and inferior pure-bred sires.

5. The use of pure-bred dams as well as sires will greatly hasten improvement in herds.

6. Registration papers are the evidence of pure breeding. Best results in livestock improvement can be expected only when all eligible animals are registered and pedigrees carefully studied.

7. All kinds of livestock are more profitable when well fed and cared for; good breeding helps feed to give the best results.

8. Keep breeding stock free from disease and parasites by close attention to sanitation and by prompt veterinary treatment when needed.

9. Inbreeding should be practised only by the most skilful breeders and by them only when they have detailed knowledge of the ancestry of the animal used.

10. Keep records of performance of your breeding animals.

### *Feeding Cattle.*

Pasture is usually the cheapest feed as well as one of the best for feeding either beef or dairy cattle. Ordinarily during spring and summer, when pastures are good, cattle require but little, if any, other food; however, dairy cows which are giving a large flow of milk and beef cattle which are being fattened for market will usually produce greater returns when the pasture is supplemented by other feed.

The limits of this leaflet do not permit a detailed discussion of feeding various kinds of cattle at different ages and at different seasons of the year, but the principal essentials of feeding may be summed up briefly as follows.

### *Ten Points in Better Feeding.*

1. Growing animals make the best use of feeds; keep them growing.
2. Weaning time is a critical period; start feeding before weaning.
3. Balanced rations supply animals' needs with least feed.
4. Water and salt should always be accessible to animals.
5. Legumes, pastures, and succulent feeds aid production and profit.
6. Feed liberally for large production; mere maintenance yields no profits. Also feed regularly.
7. Breeding animals should be kept thrifty, not overfat.
8. Good feeding equipment prevents waste of feed and labour.
9. Parasites, exposure, and overcrowding retard growth and waste feed.
10. Feed costs are important; not all balanced rations yield equal profit.

# NOTES

## SUGAR REFINED FROM *GUR* IN INDIA IN 1929-30.

Of the concerns in India equipped for refining *gur* or raw sugar, 19 are sugar factories which also manufacture sugar direct from cane and 14 are equipped for refining only. Of the former, only two refined *gur* during the season 1929-30, and of the latter, nine worked during the year, three were silent and returns from two have not been received. There were thus 11 factories refining *gur* as against 14 during the season 1928-29.

The figures of *gur* or raw sugar melted, sugar made and molasses obtained in the whole of India during the season 1929-30 are given below. The figures for the concerns in the United Provinces and Madras and the Punjab are also given separately for the information of those interested.

*Total for the United Provinces.*

| | 1929-30 | 1928-29 |
|---|---|---|
| | Mds. | Mds. |
| *Gur* or raw sugar melted | 5,94,735 | 7,30,260 |
| Sugar made | 3,11,931 | 3,62,848 |
| Molasses obtained | 2,22,635 | 2,91,857 |
| *Total for Madras and the Punjab.* | | |
| *Gur* or raw sugar melted | 4,25,368 | 7,01,225 |
| Sugar made | 2,63,778 | 4,08,292 |
| Molasses obtained | 1,28,488 | 2,17,561 |
| *Grand Total for India.** | | |
| *Gur* or raw sugar melted | 10,20,103 | 15,91,610 |
| Sugar made | 5,75,709 | 8,44,845 |
| Molasses obtained | 3,51,123 | 5,77,699 |

* Grand total for 1928-29 includes the figures of Bihar and Orissa.

A note published in Vol. I, pt. 2 of this Journal gives the total quantity of sugar produced by factories making sugar direct from cane for the two years 1929-30 and 1928-29 as follows :—

| | |
|---|---|
| 1929-30 . . . . . . . | 24,43,486 mds. or 89,768 tons. |
| 1928-29 . . . . . . . | 18,52,322 „ „ 68,050 „ |

If the quantity of sugar refined from *gur* or raw sugar in India by modern processes during these two seasons be added to the above figures, the total production will amount to 30,19,195 maunds, or 110,918 tons in 1929-30, as compared with 26,97,167 mds., or 99,088 tons, in 1928-29.

The following table shows the production of sugar direct from cane and from refining *gur* or raw sugar during the last eleven seasons :—

*Production of Sugar.*

| | Direct from cane Maunds | Refined from *gur* Maunds | Total Maunds |
|---|---|---|---|
| 1919-20 . . . . . . . . | 6,28,920 | 12,11,274 | 18,40,194 |
| 1920-21 . . . . . . . . | 6,69,291 | 13,24,645 | 19,93,937 |
| 1921-22 . . . . . . . . | 7,53,638 | 13,03,433 | 20,57,071 |
| 1922-23 . . . . . . . . | 6,51,415 | 13,68,126 | 20,19,541 |
| 1923-24 . . . . . . . . | 10,44,856 | 15,38,304 | 25,83,160 |
| 1924-25 . . . . . . . . | 9,21,950 | 9,16,121 | 18,38,071 |
| 1925-26 . . . . . . . . | 14,45,061 | 10,47,420 | 24,92,481 |
| 1926-27 . . . . . . . | 17,16,426 | 15,91,997 | 33,08,423 |
| 1927-28 . . . . . . . | 18,45,752 | 14,16,926 | 32,62,678 |
| 1928-29 . . . . . . . . | 18,52,322 | 8,44,845 | 26,97,167 |
| 1929-30 . . . . . . . . | 24,43,486 | 5,75,709 | 30,19,195 |

It will be seen that the quantity of sugar refined from *gur* or raw sugar shows a marked decrease which is due to the fact that prices of sugar continued to decline; the increase of Rs. 1-8 per cwt. in the import duty was practically neutralized by the continued fall in the world's price of sugar and some refineries were unable to provide themselves with raw material for more than a few months' working. The price of refining *gur* was also higher as will be seen from the following quotations

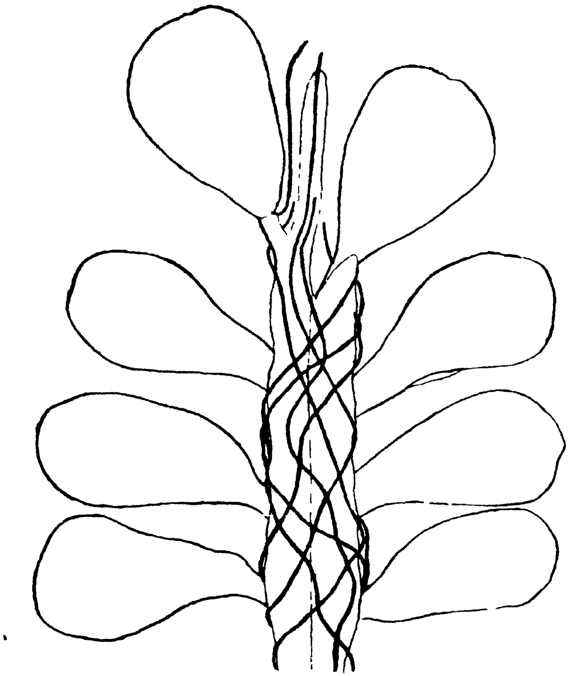

Fig. 1. Camera lucida drawing of the placental wall with the ovules intact, showing the course of the pollen tubes.

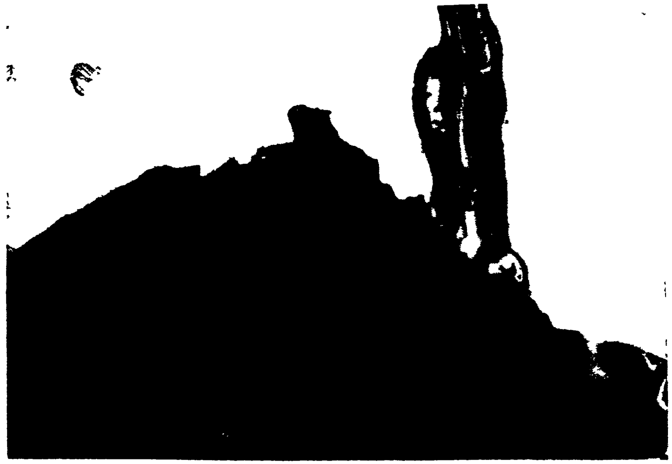

Fig. 2. Microphotograph of the micropyle end of an ovule with two pollen ubes entering it.

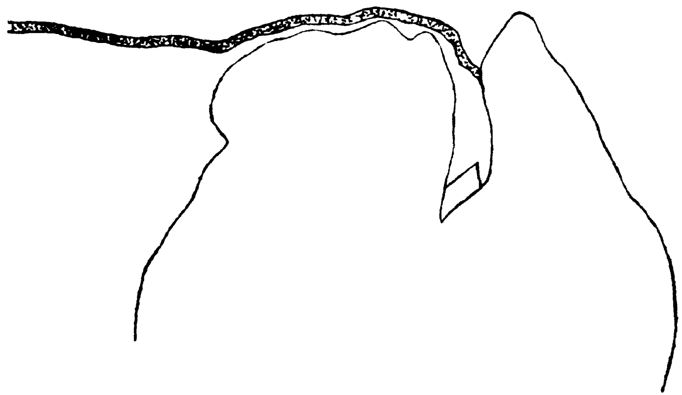

Fig. 3. Camera lucida drawing of an ovule, showing the pollen tube clinging to the crushed micropylar end.

(price per maund) obtained from Siswa Bazar which is one of the principal markets for this commodity.

| | Year 1928 | Year 1929 | Year 1930 |
|---|---|---|---|
| January . . . . . . . . . | Rs. 3 to „ 3-10-0 | Rs. 3-9-0 to „ 4-6-0 | .... |
| February . . . . . . . . . | Rs. 3-2-0 to „ 3-14-0 | Rs. 3-14 0 to „ 4-9-3 | Rs. 4-3-0 to „ 5-4-0 |
| March . . . . . . . . . | Rs. 3-4-0 to „ 4-3-0 | Rs. 4-1-0 to „ 4-12-0 | Rs. 4-6-0 to „ 5-6-6 |
| April . . . . . . . . . | Rs. 3-12-0 to „ 4-7-0 | Rs. 4-3-6 to „ 4-14-0 | Rs. 4-8-0 to „ 5-8-0 |
| May . . . . . . . . . | Rs. 3-14-0 to „ 4-6-0 | .... | Rs. 4-11-0 to „ 5-8-0 |

The recent further increase in the rate of import duty on all grades of sugar excluding molasses, coupled with the fact that the prices of refining *gur* this season are lower (January 1931—Rs. 2-14-0 to Rs. 3-7-0, February 1931—Rs. 2-14-0 to Rs. 3-5-0, March 1st two weeks—Rs. 2-14-6 to Rs. 3-6-6 per maund) and that molasses are selling at a better figure, will, it is hoped, enable more refineries to work in the season 1931.

In conclusion, the writer wishes to express his obligations to the Managing Agents, Proprietors and Managers of the various concerns for kindly furnishing the figures worked up in this note. [K. D. NAIK.]

## POLLEN TUBE ENTRY INTO COTTON OVULE.

In the course of the examination of an one-day old ovule in a withered cotton flower under the dissecting microscope, a small thread-like structure was found firmly attached to the micropylar end. A more detailed inspection revealed it to be a pollen tube. This observation was later on confirmed by the presence of similar tubes on a large number of ovules among the 7,000 ovules under study.

These tubes were found to be quite intact even when the ovules were crushed and teased. (Plate XXXVIII). It was also noticed that the absence of any remnant

of a pollen tube at the micropylar ends of ovules of that age might be taken as a sure sign that the pollen tubes had not reached the ovules.

Though the pollen tubes may be distinguished on an ovule, with a dissecting lens, they will be more clearly seen when the ovules are examined, under the low power of microscope on a watch-glass containing a few drops of lactic phenol.* This observation will be very useful to demonstrate the entry of pollen tubes into ovules to the students who are accustomed to see them only in illustrations given in books, and also to study the relative rates of growth of pollen tubes without taking recourse to the tedious and time-consuming method of observing in microtome sections. [G. SESHADRI AIYANGAR.]

* Lactic phenol is a reagent that is generally used to stain protoplasm and pollen tubes in particular. It is made by adding 0·1 grm. of cotton blue to 100 c. c. of liquid made up of equal parts of distilled water, conc. glycerine, lactic acid and 1 per cent. carbolic acid. A drop of glacial acetic acid added to a few drops of this, just before use, is very effective in making the pollen tube clearly visible.

## TREATMENT OF CATTLE INFESTED WITH WARBLES.

The following instructions for treatment of cattle infested with warbles have been issued by the Warble Fly Committee of the Worshipful Company of Leather-sellers :—

The committee have reviewed the various methods of killing warbles in the backs of cattle during the spring, and they confidently make the undermentioned recommendations to stock-owners :—

### FORMULA OF DRESSING (Derris-soap-wash).

(Used in the successful experiments carried out by the Worcestershire Agricultural Education Sub-Committee in 1929.)

Quantities sufficient for one dressing of 120 cattle with average warble infestation :—

| | |
|---|---|
| *Derris Powder | 1 lb. |
| Soft Soap | ¼ lb. |
| Water | 1 gallon. |

* The only form of Derris Powder as yet approved by the Committee is sold under the name of "Polvo" by Cooper, McDougall & Robertson, Ltd., Berkhamsted, Herts. The material is quite harmless to the flesh and hair of cattle.

### PREPARATION OF DRESSING.

Dissolve the soft soap in about one quart of boiling water and allow to cool; pour it gradually over the Derris Powder in a bucket, stirring well so as to wet every particle; make up to one gallon with cold water.

The mixture is now ready for immediate use. Fresh material should be prepared and used at each dressing.

### Application of dressing.

For convenience among cattle provide a small bucket (or water-can with partly covered top) to hang on left arm; after well agitating pour in one or two quarts of the "muddy" liquid. Apply with small piece of soft cloth to warble lumps as follows:—

> "With the right hand locate positions of all warbles on one side of the animal; rub each lump quickly with the "muddy" cloth to remove scab, if present; dress again in the same order with saturated cloth to ensure penetration of liquid through the hide punctures. Examine other side of animal and treat similarly. Look for warbles in front of shoulder and behind hip. Do not miss young warbles under very small lumps."

With care a 100 per cent. kill may be obtianed.

### Times of dressing.

As all the warbles do not develop simultaneously, cattle must be examined, and dressed if required, at least four times.

| | |
|---|---|
| First dressing . . . . . . . . . . | *Middle of March. |
| Second dressing . . . . . . . . . . | 28 days later. |
| Third ,, . . . . . . . . . . | 28 days later. |
| Fourth ,, . . . . . . . . . | 28 days later. |

*In districts where it is necessary to give the first dressing at or before this period a fifth examination, as a safety precaution, is essential 28 days after the fourth dressing. Under Worcestershire conditions, the first dressing can be delayed until the 28th March; four dressings in all are required.

Cattle purchased between the fixed times of dressing must be treated immediately upon arrival on the farm and before being turned out.

### Dressing tied-up cattle.

Dairy cows in the milking shed or byre are easily and expeditiously dealt with.

### Dressing other cattle.

Cattle that are loose must be collected in a closely confined space (a shed or part of a yard), with just enough room for a man to move among them. One animal must be examined and dressed before another is commenced.

### Quantity of dressing required.

For general guidance it may be assumed that, for a herd of 30 animals with an average warble infestation, 1 lb. of "Polvo" will be sufficient for the season, *i.e.*, four dressings.

If several of the animals have large numbers of warbles, double this amount may be required; even so, the cost of the material is relatively small.

SUMMER DRESSINGS TO PREVENT EGG-LAYING.

In some quarters it has been suggested that summer dressings to prevent egg-laying might be effective. The Committee have carefully examined this question and cannot recommend this method of treatment as a practical and effective measure for the control of the warble fly.

## AWARD OF THE MAYNARD-GANGA RAM PRIZE.

In 1925, the late Sir Ganga Ram, Kt., C. I. E., M. V. O., R. B., Lahore, with that generosity for which he was so well known, handed over to the Punjab Government a sum of Rs. 25,000 for the endowment of a prize of the value of Rs. 3,000 to be called the Maynard-Ganga Ram Prize and to be awarded every three years, for a discovery, or an invention, or a new practical method which will tend to increase agricultural production in the Punjab on a paying basis. The competition is open to all throughout the world. Government servants are also eligible to compete for it.

Sixty-four entries were received in competition for the first award of this prize. Out of this number, however, only fourteen complied with the conditions of award. Four Committees of judges were appointed to examine and report on these entries. Their reports were considered finally by the Managing Committee of the prize on 3rd March, 1931, when it was decided that the prize should be awarded to Dr. C. A. Barber, D.Sc., C.I.E., 294, Cherryhinton Road, Cambridge, for his fundamental discoveries which have resulted in the production of Coimbatore seedling sugarcanes. These canes have been definitely proved to be much higher yielders under Punjab conditions than the old indigenous varieties. The area under Coimbatore sugarcanes in the Province is increasing rapidly each year, and it is expected that they will totally replace indigenous varieties in a few years' time.

Applications for the next award should reach the Director of Agriculture, Punjab, Lahore, on or before the 31st December, 1932.

## HUMBERT-MARIE JOSÉ PRIZE.

The following regulations for the grant of the Humbert-Marie José Prize have been approved by the Permanent Committee of Institut-International d' Agriculture, Rome :—

1. An annual prize, which on account of the circumstances under which it was endowed is to be known as Humbert-Marie José Prize, is instituted for the best work in Agricultural Economics—comprising all problems relating to Economics and Agricultural Statistics.

The prize consists of a gold medal and a sum of 10,000 liras, and will be awarded by the Permanent Committee in all years, according to these regulations.

The date (of receipt of work) expires on the 30th September and the award will take place on the 31st December 1930.

2. The work of authors belonging to the countries adhering to the Institute and published in the course of the preceding two years will be alone admitted to the competition.

3. If any work is published in many parts then it is admitted as a whole, at the period in which the final part has been published.

4. A new edition of any work published previous to the period will not be admitted unless substantial changes or additions have been made.

5. Work carried out by any member of the Jury will not be admitted to the competition. nor any work which has already been submitted to any International Competition and for which the author has received any prize in cash.

6. At the close of each period the General Secretary of the Institute will invite the members of the Committee for Rural Economics and Statistics of the International Council for Scientific Agriculture of the Institute, as well as of the Committee for Agricultural Economics, to forward 6 copies of work carried out by their respective countrymen, which in their opinion deserve to be submitted to the International Jury by reason of their scientific merit. He may, if necessary, point out any publications known to him which conform to the conditions of the competition.

The members of the International Council of Scientific Agriculture and of the Committee for Agricultural Economics who forward any work for the competition should also send with the copies of the work in all important cases, a brief report indicating the nature and contents of the work as well as their personal appreciation of its scientific character.

Works transmitted directly by the authors to the Institute will be sent by the General Secretary to a member of the Competent Section of the International Council of Scientific Agriculture or of the Committee for Agricultural Economics for report as mentioned above.

7. The final judgment in the competition will be given by a Jury composed of 5 members consisting of the President of the Institute, and 4 members nominated from among the members of the International Council of Scientific Agriculture and the Committee for Agricultural Economics. The selection will be made in such a manner that the Jury will be composed of men belonging to 5 different nationali-

ties. Each member of the Jury may have a substitute only of the same nationality.

8. A copy of all the works presented to the competition and of the reports accompanying them will be sent to each member of the Jury. The Jury cannot examine any other work besides those officially sent to them.

9. Each member of the Jury after examining the works will draw up his order of preference and transmit it to the General Secretary. If any work placed at the top obtains 3 votes, then the prize is awarded. If no work obtains 3 votes, the General Secretary will draw up a list composed of two works placed at the top of the list obtaining the greatest number of votes, and send it to the members of the Jury for a fresh ballot. The result of the second voting will determine the prize.

*N.B.*—Expiry of the second period for the presentation of work : 30th September 1931 ; Grant of the Prize : 31st December 1931.

# Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

The HON'BLE SIR C. P. RAMASWAMI AYYAR, K.C.I.E., has been elected by the Council of State as its representative on the Imperial Council of Agricultural Research.

MAULVI MUHAMMAD SHAFEE DAOODI, M.L.A., and LALA HARI RAJ SWAROOP, M.L.A., have been elected by the Legislative Assembly as its representatives on the Imperial Council of Agricultural Research.

His Excellency the Governor General in Council has been pleased to appoint the following to be members of the Imperial Council of Agricultural Research:—

(1) Revenue Member of His Exalted Highness the Nizam's Government.
(2) Director, Veterinary Services in India.
(3) Director of the Agricultural Department of His Exalted Highness the Nizam's Government.
(4) Director of the Veterinary Department of His Exalted Highness the Nizam's Government.
(5) Chief Publicity Officer, Indian State Railways.
(6) Mr. S. M. A. Shah, B.Sc., Superintendent, Civil Veterinary Department, North-West Frontier Province.

MR. A. D. BLASCHECK, F.C.H., OEC. D., I.F.S., Inspector-General of Forests, has been nominated by the Government of India as the representative of the Forest Research Institute, Dehra Dun, on the Imperial Council of Agricultural Research.

MR. D. MILNE, C.I.E., B.Sc., I.A.S., Director of Agriculture, Punjab, has been appointed to officiate as Agricultural Expert, Imperial Council of Agricultural Research, *vice* Mr. B. C. Burt on leave.

The Services of Mr. T. S. SABNIS, M.Sc., I.A.S., temporary Hemp Marketing Officer, Imperial Council of Agricultural Research, have been replaced at the disposal of the Government of the United Provinces, with effect from the 17th April 1931.

MR. G. R. DUTT, B.A., temporary Entomologist, Locust Bureau, Imperial Council of Agricultural Research, relinquished charge of his post on the afternoon of the 11th April, 1931.

DR. W. H. HARRISON, D.Sc., I.A.S., Imperial Agricultural Chemist and Joint Director, Imperial Institute of Agricultural Research, Pusa, has been granted combined leave from the 7th March to 15th October, 1931, preparatory to retirement.

DR. W. MCRAE, D.Sc., I.A.S., Imperial Mycologist, has been appointed Joint Director of the Imperial Institute of Agricultural Research, Pusa, *vice* Dr. Harrison on leave.

DR. B. A. KEEN, D.Sc., F.Inst.P., Director, Imperial Institute of Agricultural Research, Pusa, assumed charge of the duties of the Imperial Agricultural Chemist, in addition to his own, with effect from the afternoon of the 6th March, 1931.

In consequence of vacancies caused by the retirement of nominated members with effect from the 1st April, 1931, the following have been nominated to be members of the Indian Central Cotton Committee, Bombay :—

SETH NARANLAL JIVANLAL—to represent the Ahmedabad Millowners' Association.

MR. CHUNILAL B. MEHTA—to represent the Indian Merchants' Chamber, Bombay.

MR. D. MCCALLUM—to represent the Karachi Chamber of Commerce.

MR. MOHAMAD AZHAR ALI, M. L. A., of Lucknow, has been appointed a Member of the Indian Central Cotton Committee, Bombay.

*Madras.*

MR. M. GOVINADA KIDAVU, DIP. AGRI., Deputy Director of Agriculture, Fourth Circle, Madras Presidency, has been granted combined leave for six months and 17 days from the 8th April, 1931.

MR. V. RAMANATHA AYYAR, L.AG., Offg. Cotton Specialist, Madras Presidency, has been granted leave on average salary for four months with effect from the 15th April, 1931.

MR. G. N. RANGASWAMI AYYANGAR, B.A., I.A.S., Millet Specialist, Coimbatore, will hold additional charge of the Cotton Specialist during the absence, on leave, of Mr. Ramanatha Ayyar.

RAO BAHADUR B. VISWANATH, F. I. C., F. C. S., Agricultural Chemist, Coimbatore, has been granted leave on average pay for four months with effect from the 1st March, 1931, or date of relief.

MR. K. S. VISWANATHA AYYAR, B.A., has been appointed to act as Agricultural Chemist, Coimbatore, *vice* Rao Bahadur B. Viswanath on leave.

MR. K. RAMIAH, L.AG., M.SC., DIP. AGRI., has been appointed Paddy Specialist, Coimbatore, with effect from the 27th July, 1930.

MR. F. H. BUTCHER, Curator, Government Botanical Gardens and Parks, Ootacamund, has been granted leave on average pay for eight months with effect from the 1st April, 1931.

MR. D. G. MUNRO, B.SC., I.A.S., Deputy Director of Agriculture, VIII Circle, Madras Presidency, has been placed in charge of the Agricultural Research Station, Nanjanad, and the fruit stations at Coonoor, Berlier and Kallar, in addition to his own duties, *vice* Mr. Butcher on leave.

MR. V. NARAYANASWAMI AYYAR, M.A., Offg. Systematic Botanist, Coimbatore, has been placed in charge of the Botanical Gardens at Ootacamund and Sun's Park at Coonoor, in addition to his own duties, *vice* Mr. Butcher on leave.

MR. T. J. HURLEY, M. R. C. V. S., D. V. S. M., I. V. S., Principal, Madras Veterinary College, has been granted leave on average pay for five months with effect from the 2nd July, 1931, with permission to prefix the midsummer vacation.

*Bombay.*

MR. W. M. SCHUTTE, A. M. I. Mech. E., M. R. A. S. E., Agricultural Engineer to Government, Bombay, has been granted combined leave from the 20th September, 1931, to the 13th November, 1933.

DR. G. S. CHEEMA, D. Sc., Horticulturist to Government, Bombay, has been granted leave on average pay for six months and 15 days with effect from the 10th May, 1931.

MR. H. P. PARANJPYE, District Horticultural Officer, Poona, has been appointed to act as Horticulturist to Government, Bombay, *vice* Dr. G. S. Cheema on leave.

RAO BAHADUR D. L. SAHASRABUDHE, M.AG., M.SC., Agricultural Chemist to Government, Bombay, has been placed on special duty for a period of three months in connection with the collection of data on manurial experiments .

MR. V. N. GOKHALE has been appointed to act as Agricultural Chemist to Government, Bombay, *vice* Rao Bahadur D. L. Sahasrabudhe placed on special duty.

*Bengal.*

MR. F. J. GOSSIP, Live-stock Expert to the Government of Bengal, has been granted leave on average pay for eight months with effect from the 26th March, 1931.

MR. JADU NATH SARKAR, M.S.A., has been appointed to act as Deputy Director of Agriculture, Western Circle, in the Bengal Higher Agricultural Service, with effect from the 1st May, 1930.

MR. DWIJADAS DATTA, B.Sc., M.S.A., has been appointed to act as Second Economic Botanist to the Government of Bengal, in the Bengal Higher Agricultural Service, with effect from the 1st May, 1930.

MR. ABDUL RASHID MALIK, M.A., B.Sc., has been appointed to act as Deputy Director of Agriculture, Northern Circle, in the Bengal Higher Agricultural Service, with effect from the 1st May, 1930.

MR. P. J. KERR, M.R.C.V.S., I.V.S., Veterinary Adviser to the Government of Bengal, has been granted combined leave for six months and 19 days with effect from the 26th March, 1931.

MR. A. D. MACGREGOR, F. R. C. V. S., I. V. S., Principal, Bengal Veterinary College, has been appointed to officiate as Veterinary Adviser to the Government of Bengal, in addition to his own duties, during the absence, on leave, of Mr. P. J. Kerr.

## *Punjab.*

MR. H. R. STEWART, F. R. C. Sc. I., D. I. C., N.D.A., I.A.S., Assistant Director of Agriculture, Punjab, has been appointed to officiate as Director of Agriculture, Punjab, Lahore, with effect from the afternoon of the 31st March, 1931, *vice* Mr. D. Milne appointed to officiate as Agricultural Expert, Imperial Council of Agricultural Research.

SARDAR DARSHAN SINGH, M. R. A. C., F. R. H. S., M. R. A. S., I. A. S., Deputy Director of Agriculture, Punjab, has been promoted to the selection grade in the I. A. S., with effect from the 1st January, 1931.

MR. D. P. JOHNSTON, A. R. C. Sc. I., N. D. A., I. A. S., Offg. Professor of Agriculture, Punjab Agricultural College, Lyallpur, has been granted combined leave for 8½ months with effect from the 21st February, 1931.

SARDAR LABH SINGH, L.AG., B.SC. (AGRI.), has been placed incharge of the duties of the Professor of Agriculture, Punjab Agricultural College, Lyallpur, with effect from the 21st February, 1931, *vice* Mr. D. P. Johnston on leave.

SARDAR KARTAR SINGH, L.AG., B.SC., (AGRI.), N. D. D., has been placed incharge of the duties of Associate Professor of Agriculture, Punjab Agricultural College, Lyallpur, with effect from the 21st February, 1931, *vice* Sardar Labh Singh placed incharge of the duties of Professor of Agriculture.

On the termination of the temporary post of Entomologist to Government, Punjab, in the Indian Agricultural Service, held by him, MR. M. AFZAL HUSAIN, M.Sc., M.A., I.A.S., has been appointed to the post of Entomologist to Government, Punjab, in the Punjab Agricultural Service, Class I, from the 17th September, 1930.

MR. T. A. MILLER BROWNLIE, C. E., M. I. W. E., M. I. M. and C. E., Agricultural Engineer to Government, Punjab, and Principal, Punjab Agricultural College, Lyallpur, has been granted leave for eight months with effect from the 11th March, 1931.

DR. P. E. LANDER, M. A., D. Sc., A. I. C., I. A. S., Agricultural Chemist to Government, Punjab, has been appointed to officiate as Principal, Agricultural College, Lyallpur, in addition to his own duties, with effect from the 11th March, 1931, *vice* Mr. Miller Brownlie on leave.

SHAIKH MAHBUB ELAHI, C. E., A. M. I. W. E., M. R. S. I., Second Agricultural Engineer to Government, Punjab, has been placed incharge of the duties of Agricultural Engineer to Government, Punjab, with effect from the 11th March, 1931, *vice* Mr. Miller Brownlie on leave.

MR. R. BRANFORD, M. R. C. V. S., I. V. S., Livestock Officer to Government, Punjab, retired from Government service with effect from the 15th November, 1930.

The appointment of the following officers to special temporary posts in the Civil Veterinary Department, Punjab, has been extended for a further period of one year with effect from the dates noted against each :—

SAIYED MUBARAK ALI SHAH GILANI, B.Sc., M.R.C.V.S.—30th July, 1930.

LALA PRAN NATH NANDA, M.R.C.V.S.—30th July, 1930.

LALA RAM RATTAN GHULATI, M.R.C.V.S.—6th November, 1930.

SARDAR SANTOKH SINGH, B.A., B.Sc. (AGRI.), N.D.D.—16th January, 1931.

LALA BAIJ NATH HANDA, B.Sc., M.R.C.V.S.—12th March, 1931.

SAIYED IQBAL ALI SHAH, M.R.C.V.S.—22nd March, 1931.

The appointment of LALA AMIN CHAND AGGARWALA, B.Sc., M.R.C.V.S., as Professor of Hygiene and Dietetics at the Punjab Veterinary College, Lahore, has been extended for a further period of one year from the 19th January, 1931.

*Burma.*

On return from leave, MR. A. MCKERRAL, M.A., B.Sc., I.A.S., has been reposted to the charge of the office of the Director of Agriculture, Burma, with effect from the 23rd February, 1931.

MR. T. D. STOCK, D.I.C., A.R.C.S., B.Sc., I.A.S., Deputy Director of Agriculture, Burma, has been granted combined leave for eight months with effect from the 13th March, 1931.

MR. D. RHIND, B.Sc., I.A.S., Economic Botanist, Burma, has been granted combined leave for eight months with effect from the 14th April, 1931.

MR. H. F. ROBERTSON, B.Sc., I.A.S., Professor of Agriculture, Agricultural College, Mandalay, has been appointed to officiate as Economic Botanist, Burma, in addition to his own duties, *vice* Mr. Rhind on leave.

### *Central Provinces.*

Rai Sahib Bhaiyalal Dube, L.Ag., has been posted as Deputy Director of Agriculture, North-Western and Plateau Circle, Central Provinces, with effect from the 16th January, 1931.

Mr. D. V. Bal, L.Ag. (Hons.), F.C.S., has been appointed to officiate in the Central Provinces Agricultural Service, Class I, as Agricultural Chemist, Central Provinces, with effect from the date on which he assumes charge of his duties.

### *Assam.*

Mr. A. G. Birt has been appointed Director of Agriculture, Assam, with effect from the 1st April, 1931.

# REVIEW

**The Milk Problem of the City of Hyderabad and the British Administered Areas.**—By R. R. JOSHY, G.B.V.C., His Exalted Highness the Nizam's Civil Veterinary Department.

In this pamphlet the author, after reviewing the conditions under which milk is produced and supplied to the areas dealt with, makes numerous suggestions for improvement which, though the practicability of some of them under existing circumstances is open to doubt, should undoubtedly result in a much improved milk-supply. In his recommendations, State and municipal assistance are relied on to a large extent; for the provision of more adequate supplies of forage; for the co-operative organization of dairying; and for the education of the public as to the great value to health of an adequate and pure milk-supply.

That such assistance is much to be desired there is no doubt, particularly in the early stages of establishing a satisfactory milk industry. Experience has, however, shown that an industry must eventually be compelled to set its own house in order, by improved business methods and co-operation, in order to meet a demand for a better and cleaner milk by an enlightened public.

The first step in ensuring such a demand is a system of government or municipal testing, for butter-fat and bacterial content, which will ensure that the milk delivered to consumers is reasonably pure and clean at the time of delivery. Such a system of testing is now applied, at government or municipal expense, in every enlightened community. Without such assistance and the power, supported by educated public opinion, to punish delinquents, no great advance can be expected.

So long as it is more profitable and quite safe to supply a debased product, human nature being what it is, the ordinary milk vendor can hardly be expected to incur the added expense and trouble involved in the supply of milk of a higher grade [A. O.]

# CORRESPONDENCE

## THE WHITE-FLY OF COTTON.

To

THE EDITOR, *Agriculture and Live-stock in India.*

Sir,

" I have read with much interest Mr. Husain's detailed note on the " White-fly " of cotton in the November (1930) issue of the *Agricultural Journal of India* (Vol. XXV, Pt. VI). His criticism of my contribution is eminently fair and I admit forthwith it is a case of ' touche ' in one or two instances.

As regards the relative infestation of 289F and 4F, it appears that, up to August, 289F showed distinctly less infestation than 4F. There is some indication that early spraying is more effective than late spraying and the July attacks might possibly affect yield more than August-September attacks. Be that as it may, we are told nothing *re* ultimate yields of the plots or plants compared. Without that the method employed means very little. In my articles I have quoted relative average yields of 4F and 289F for several years, and it is quite obvious from those figures that, whatever the cause, 289F is far more immune than 4F. Our observations during bad years such as 1928 and 1929 at Khanewal, though lacking the scientific precision of Mr. Husain, certainly indicated heavier infestation of 4F.

Further the cage experiments give strong indications, which are fully confirmed in this last season's work, *re* the vital importance of " White fly " as it affects yields. The ' disease ' or failure of the crop is more important to me than the " White-fly " as such, but even so Mr. Husain's and Mr. Trehan's researches go to prove more and more that " White-fly " is the vital factor in the case.

As regards the " White-fly " not having been connected with the failure of the crop prior to 1928 when Mr. Thomas drew attention to it, the fact is remarkable that the survey done that year under Mr. Husain's directions showed " White-fly " to be very prevalent in the identical tracts where the crop suffered in that and previous years.

*Re* 3F in 1913, Mr. Husain is probably right *re* Jassid being the main cause, but the writer recalls a remark of the late Mr. Howlett during a visit to Lyallpur

about 1914 in which he said that he found much more " White-fly " about, in the cotton, than Jassid, and he doubted whether we were always accurate in our nomenclature.

My colleague Mr. Roger Thomas has prepared a note on the " White-fly " which will, I think, throw some further light on the cotton failure.

I should like, in closing, to pay a tribute to the excellent work being done by Mr. Husain and his Assistant, Mr. Trehan, in the study of the " White-fly " during the last two years."

Yours faithfully,

W. ROBERTS.

# NEW BOOKS

## On Agriculture and Allied Subjects.

1. Environment and Plant Development. By Henrik Lundegardh. Translated and edited from the Second German Edition by Eric Ashby, pp. XII + 330 + 8 plates. (London : Edward Arnold and Co., 1931.) 24*s*. net.

2. A Text-book of Economic Zoology. By Z. P. Metcalf. Pp. 392. (London : Henry Kimpton, 1931.) 18*s*. net.

3. Chinese Farm Economy : a study of 2866 Farms in Seventeen Localities and Seven Provinces in China. By John Lossing Buck. Published for the University of Nanking and the China Council of the Institute of Pacific Relations. Pp. XII + 476. (Chicago : University of Chicago Press, London ; Cambridge University Press, 1931.) 22*s*. 6*d*. net.

4. The Place of Agriculture in American Life. By Wilson Gee. (The World of to-day Bookshelf.) Pp. IX + 217. (New York : The Macmillan and Co., 1930.) 8*s*. 6*d*. net.

5. Crop Production, Principles and Practices : a Handbook of Information for the Student of Agriculture. By Harold D. Hughes and Edwin R. Henson. Pp. x + 816. (New York : The Macmillan and Co., 1930.) 25*s*. net.

6. The Microscopic Examination of Cattle Foods : a Text-Book for the Diagnosis of Cattle Food Materials, including a Description of the Plant Ingredients commonly used in Cattle Cakes and Meals, Methods of preparing Samples for Analysis and Five Tables of comparison. By S. T. Parkinson and W. L. Fielding. Pp. VIII + 97 (15 plates). (Ashford and London : Headley Brothers, 1930.) 6*s*. 6*d*. net.

7. Guide to the Study of Animal Parasites. By Dr. William A. Riley and Reed. O. Christenson. (McGraw-Hill Publications in the Zoological Sciences.) Pp. XV + 131. (New York : McGraw-Hill Book Co., Inc. ; London : McGraw-Hill Publishing Co., Ltd., 1930.) 7*s*. 6*d*. net.

8. Physiology and Biochemistry of Bacteria. By Professor R. E. Buchanan and Prof. Ellis. I. Fulmer. Vol. I ; *Growth Phases* ; *Composition and Biophysical Chemistry of Bacteria, their Environment and Energetics*. Pp. XI + 516. 34*s*. net. Vol. 2 : *Effects of Environment upon Microorganisms*. Pp. XVII + 709. 34*s*. net. Vol. 3 : *Effects of Microorganisms on Environment ; Fermentative and other Changes Produced*. Pp. XV + 575. 34*s*. net. (London : Bailliere, Tindall and Cox, Vol. 1, 1928 ; Vols. 2 and 3, 1930.)

9. Medical Research Council. A System of Bacteriology in relation to Medicine. Vol. 7. By C. H. Andrews, J. A. Arkwright, S. P. Bedson, F. R. Blaxall, F. M. Burnet, J. Burton Cleland, A. Felix, G. Marshall Findlay, W. Fletcher, I. A. Galloway, M. H. Gordon, J. G. Greenfield, W. E. Gye, W. F. Harvey, E. Hindle, P. P. Laidlaw, J. C. G. Ledingham, R. J. Ludford, J. E. McCartney, J. McIntosh, A. G. McKendrick, H. B. Maitland, M. S. Mayou, R. St. John-Brooks, J. Henderson Smith, A. Theiler, C. Todd, J. Walker, Pp. 509. (London: H. M. Stationery Office, 1930.) 21*s*. net.

The following publications have been issued by the Imperial Department of Agriculture since our last issue :

*Memoirs.*

1. Effects of Some Meteorological Conditions on the Growth of Punjab-American Cotton, by Trevot Trought, M.A. (Botanical Series, Vol. XVII, No. 6). Price, As. 7 or 9*d*.

2. Inheritance of Characters in Rice, Part IV, by K. Ramiah, L. Ag. (Madras), M. Sc., Dip. Agri. (Cantab.), and S. Jobitharaj, B.A., and S. Dharmalinga Mudaliar, L. Ag. (Botanical Series, Vol. XVIII, No. 8). Price, Re. 1-6 or 2*s*. 3*d*.

3. A Leafspot Disease of *Andropogon Sorghum* caused by *Cercospora Sorghi* E. & E., by T. S. Ramakrishnan, M. A. (Botanical Series, Vol. XVIII, No. 9). Price, As. 10 or 1*s*.

2. A Contribution towards our knowledge of the Aleyrodidae (White Flies) of India, by Karam Singh, M. Sc. ; A New Coccid injurious to Fruit Trees in Baluchistan, by F. Laing (Entomological Series, Vol. XII, Nos. 1 and 2). Price, Rs. 3-2 or 5*s*. 6*d*.

*Bulletin.*

5. List of Publications on Indian Entomology, 1929. Compiled by the Imperial Entomologist, Pusa. (Pusa Bulletin No. 207.) Price, As. 10 or 1*s*.

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# ORIGINAL ARTICLES

## DAIRY FARM BUILDINGS IN INDIA.

BY

W. SMITH,

*Imperial Dairy Expert.*

The problem of dairy farm buildings in a tropical country like India is simpler than that which meets the cow owner in the more temperate parts of the world. Generally speaking, Indian dairy cattle only require occasional or seasonal shelter, as opposed to housing for half the year in the colder countries, and in this connection it should be stated at the outset of this article that the best and most economical way to keep and rear dairy stock of all kinds, in so far as housing is concerned in the plains of India, is to permit the animals to be at liberty at all times except when being fed or milked, and to provide for them roofed shelter from cold wind and rain that they can take advantage of when they want to. If this system be followed, it means that outside of residences of staff, the only buildings with really pucca floor, walls or supports as the case may be, and roofs, absolutely essential in Indian dairy farming are the dairy proper or milk handling room, the wash-up or can-sterilising room milking shed and milk recording room, this latter being only necessary in large dairies ; in smaller concerns recording can be done in the milking shed. Of course under certain circumstances where capital is available, it is profitable and desirable that many other of the dairy buildings such as grain stores, hospital, etc., should be pucca in every respect, but essentially only the aforementioned buildings must be pucca in order to maintain that standard of cleanliness which is necessary from an economic as well as from a hygienic point of view.

When reduced to the minimum of expense from the building point of view, what the Indian dairy farmer wants is fenced paddocks in which the various classes of his stock can be kept when they are not on the grazing grounds, and every such paddock must have shelter, a supply of drinking water, and arrangements made to enable the cattle to have fodder always before them without the likelihood of their wasting it by trampling it under foot. Shelter houses in paddocks may be of any class or type, but they should have water-tight roofing and be walled in on the side and end from which the prevailing wind of the district blows. It is a good plan to

have troughing inside the shelter sheds but this is not essential. Plans 1, 2, 3 and Plate XXXIII, fig. 1 illustrate different types of paddock shelters in use in India all of which are effective and none of them costly. As to the water-supply to paddocks the type of circular water tank shown in Plan 4 can supply water to four different paddocks when placed at the point where the four paddocks or enclosures touch as shown in the illustration.

In the establishment of a dairy farm, the lay-out of the buildings or their arrangement on the site in relation to one another is of great importance. A site selected for a dairy farm should have a natural slope sufficient to permit the washings and drainage to naturally flow off the area, and next to general efficiency and easy facility for working, the most important factor to be considered, in a lay-out of dairy farm buildings, is the protection of the stock from disease infection. The lay-out should be so planned that no animals of any kind other than the herd of the owner would require to come into or near to the yard or paddocks where the herd are kept and fed or milked. Carts bringing in fodder or grain or other stores, milk delivery carts, strange animals and dogs, goats or sheep, should when possible be prevented from entering the cattle-yard and the farm should be so arranged that the herd pass to and from their grazings to their night paddocks and milking shed without crossing public roads or areas frequented by outside domestic animals.

Plan 5 shows an ideal lay-out for a small dairy farm with a herd of from 50 to 100 milch cattle with dairy, wash-up room and milking shed only of pucca construction and all the other buildings of a cheap and semi-temporary type. As the Indian cow requires her calf with her at milking time, the calf shed is located near to the milking shed and the whole arrangement planned so that the cattle come and go for grazing, milking and shelter without coming into contact with the outside world of cattle around them.

Plan 6 depicts a suggested lay-out for a large dairy or cattle-breeding farm where all the cows are milked and where a milking stall is provided for each animal in milk as against the milking shed of the colonial type shown in figure 5. The colonial type of milking shed is designed so that the cow passes into the milking stall from behind and is tied up for milking, and after milking she is released and passes on through the milking stall to be followed by another cow to be milked on the same standing. In this type of milking shed one milking bail or stall will suffice for anything from three to ten cows and consequently a considerable saving in first cost is effected by its adoption. This type of milking shed is not however suitable where, as in large cattle-breeding farms, it is desirable to feed the animal its concentrate ration mixed with chopped fodder whilst being milked, or where it is desirable to keep the animals housed for a lengthy period, or to have a note of

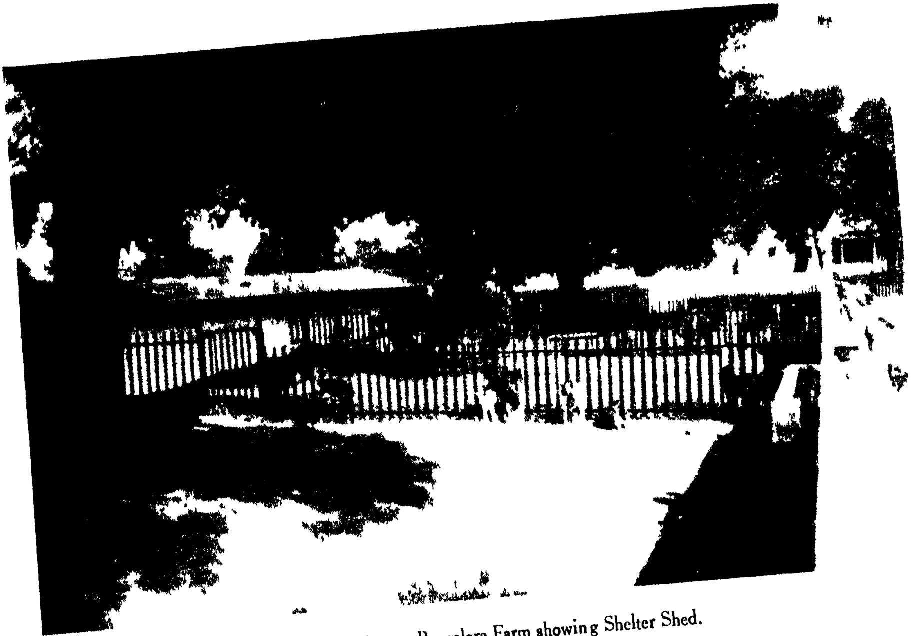

Fig. 1 --Calf Pens at Bangalore Farm showing Shelter Shed.

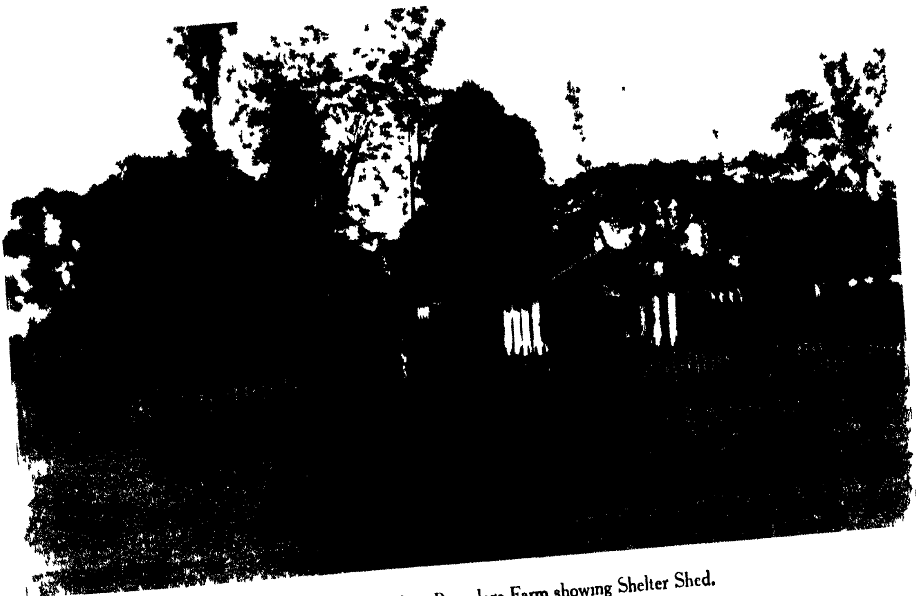

Fig 2—Bull Paddock at Bangalore Farm showing Shelter Shed.

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Fig. 1.—Calf Pens at Bangalore Farm showing Shelter Shed.

Fig. 2.—Bull Paddock at Bangalore Farm showing Shelter Shed.

PLATE XXXIV.

Fig 1—Exterior of Cattle Shed at Bangalore Farm

Fig 2—Interior of Cattle Shed at Bangalore Farm showing stanchions and partitions.

the breed and performance record of each cow on a record plate over each animal. Plan 7 is a sketch of a colonial type milking shed designed by Lieutenant-Colonel Matson, O.B.E., and recently erected at the Military Dairy Farm, Secunderabad. It will be seen from these sketches that three record plates are fixed over each stall, denoting that the same three cattle are milked one after the other in the same bail daily, the record plates bearing the milk yields and breed particulars of the three animals using the stall over which the plates are fixed.

For the colonial milking shed where a number of cows are milked daily in the same stall a light chain is the best tethering medium; but for cow sheds where the cattle are housed in the stall for any length of time the all-steel spring stanchion is the best for holding the cattle. These stanchions are lasting and the cow can be secured in a moment; cattle are perfectly comfortable in these stanchions and can lie down and lick any part of their body whilst in the bail. This type of stanchion used with a properly fixed partition of steel piping between each animal prevents the cattle from moving against their neighbours and from backing on to the foot passage and fouling the cow shed. Plate XXXIV, figs. 1 and 2 show the exterior and interior of a model cow shed in India with Indian made cow stanchions and partitions in position. This type of cow stanchion is now used in modern byres all over the world. Plan 8 illustrates the type of trough suitable for this class of standing and gives dimensions for cows and buffaloes respectively.

The lay-out as suggested in Plan 6 has been actually carried out at a number of large dairy farms in India and has proved suitable both for efficient and economical working and for disease protection. In the sketch the buildings as shown are all pucca but many of these could be built kutcha or semi-kutcha without in any way altering the efficiency of the lay-out.

In this plan (Plan 6) provision is made for the housing of a small number of young stock, but in a farm of this size if all calves are reared to maturity it is advisable to keep all the young stock from the time of weaning, until they are issued as stud bulls or brought into the herd as milkers, right out on the grazing areas, and as a protective night shelter and feeding yard for this class of stock the kraal type of inexpensive yard and sheds is recommended. Plan 9 is a plan of a young and dry stock kraal, with feeding and water troughs large enough to accommodate 400 head of stock. This is a suitable dry and young stock building for the dairy farm as planned in Plan 6, and the kraal is large enough to accommodate all the dry stock from such a farm, as well as young stock from 1 to 3½ years.

For stud bull accommodation the system of keeping each bull in a fairly large paddock with a shelter and feeding shed with a sure supply of drinking water

in the paddock is the most suitable. The shelter may be pucca or kutcha and should consist of a roof with one end and one side wall to protect the animal from wind and rain. In the hotter parts of the country where the rainfall is not too high, a mere shelter roof on supports is sufficient. Bull paddocks should be on an average of not less than 500 sq. yards for each animal. Plate XXXIII, fig. 2 is a photo showing a bull paddock and shelter at the Imperial Institute of Animal Husbandry and Dairying, Bangalore.

The types of calf houses shown in Plans 5 and 6 depict expensive and non-expensive types of shelters. In rearing of young calves the main point to be observed is that the animals should have an open exercise paddock directly communicating with their shelter and feeding house. The exercise yards should not be of a lesser area than three square yards for each calf and the calf shelters should provide ten square feet of floor area for each animal.

In all dairy farms, whether small or large, calving sheds should be provided to the extent of not less than eight per cent. of the milking herd. These may be kutcha or pucca according to the finances available. but the loose-box type as shown in Plan 6 is the most suitable.

Isolation hospitals built remote, say 1,000 yards, from the main dairy buildings, for the housing of newly-purchased cows for a quarantine period or for the separation and treatment of cattle suspected of or suffering from infectious diseases, are advisable ; and Plan 10 is a sketch of a suitable type of building which may be built of either kutcha or pucca materials.

In the larger dairy farms owning say over 100 cows, a milk recording room is advisable, and the position of this building in relation to the cattle sheds is shown in Plan 6. Plan 11 illustrates a very suitable type of recording chamber with the lower part of the walls of masonry and the upper part filled in with wire gauze. Where milk recording rooms are used the masonry part of the walls should be tiled inside with minton tiles and the floors should be good cement concrete.

Where circumstances permit grain godowns and chaffing sheds should be made pucca and rat-proof. The types of both these buildings shown in Plans 5 & 6 are suitable, but the size and class of grain stores must always be governed by local circumstances.

In Europe and America silage is made in masonry towers erected above ground, but generally speaking in India the erection of silo towers is unnecessary, as the highest quantity of silage can be made in most localities in pits dug in the ground and without any masonry whatever. In areas, however, where the water-line is high, silo towers are necessary and Plan 12 depicts a type suitable for India, and

Fig 1 —Silo Towers at Bangalore Farm

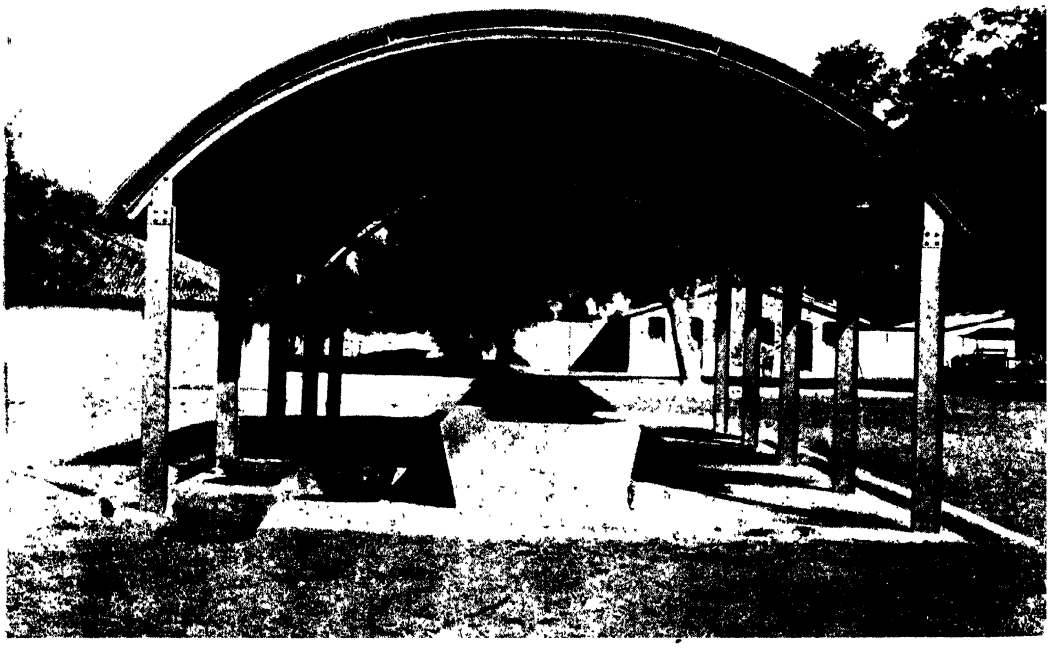


Fig. 2.—Steel Bullock Shed at Pusa Farm.

Plate XXXV, fig. 1 illustrates two silo towers at Bangalore after 20 years of continuous use.

For such buildings as implement sheds, bullock sheds, fodder sheds, etc., the type of cheap iron standardised farm building recommended by Mr. G. S. Henderson, N.D.A., N.D.D., Director of Agriculture, Bihar and Orissa, is very suitable. Buildings of this class can now be built of materials entirely manufactured in India and are cheap, lasting and to some extent portable. Plate XXXV, fig. 2 illustrates a bullock shed of this type in use at Pusa.

The plan and size of dairy buildings proper must always depend upon local conditions, *i.e.*, on the class of trade or product manufactured, whether the milk sold is pasteurised or otherwise, etc., etc., but it may be taken that all dairy buildings including the attendant wash-up and milk-vessel sterilising room should be pucca with pucca concrete floors, cement-coated or tiled inner walls and pucca roofs. All such buildings should be fitted with fly-proofed doors and windows and well lighted and freely ventilated. Plan 13 is a plan of a small dairy building for handling non-pasteurised milk and Plan 14 depicts a dairy building suitable for dealing with 2,000-3,000 lbs. of pasteurised milk per day.

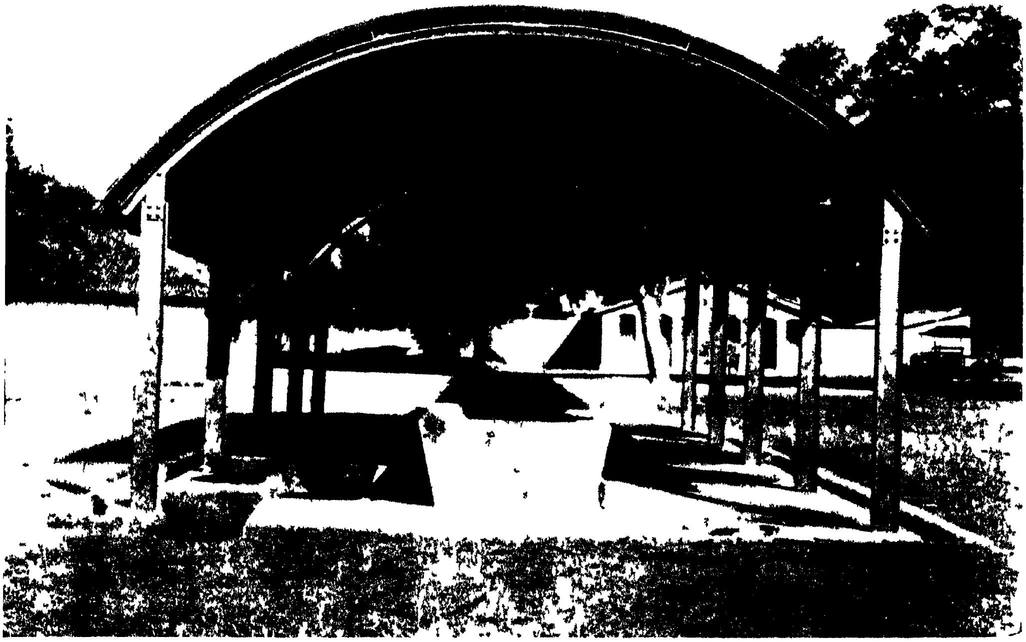
The usual European and American practice is to have the dairy and washing rooms in the one building, but in a tropical country such as India it has been found preferable to have the steam generating and washing and can-sterilising plant in a separate building. This makes for greater cleanliness and lower temperatures in the dairy building proper.

In the larger building (Plan 14) a cold storage room with air lock is provided. Insulation may be done with cork slabs or silicate cotton.

Where it is possible a running water-supply should be laid on to all dairy farm yards, and the cattle should have access to clean drinking water at all times. It may be taken that the minimum drinking water requirements of a dairy herd are 100 lbs. water per head of adult stock per day, 20 lbs. per day for each unweaned calf and an average of 60 lbs. per head per day for young stock from 1 to 3 years of age. To this should be added 10 lbs. of potable water for dairy purposes for every 1 lb. of milk produced by the herd.

In respect to building materials no hard and fast all-India rule can be laid down, with this one exception that the floors of all pucca milking sheds, whether on the colonial or one-standing-per-cow model, must be of first class cement concrete laid on lime concrete, this again being laid on rammed-morrum. The feeding troughs of all one-stall-one-cow model cow-sheds should be of reinforced cement concrete of the pattern shown in Plan 8. Cement concrete floors are water-tight, lasting, easily constructed, easily repaired, easily cleaned, and look

Fig 1 Silo Towers at Bangalore Farm



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neat and smart if kept clean. The one objection to this class of floor for cattle sheds is that after a little wear it becomes slippery and cattle are apt to slip on it and hurt themselves, but this objection can be overcome by sprinkling carborundum floor powder on to the cement when it is newly laid immediately after the final smoothing with the trowel in the wet stage. 4 lbs. of carborundum powder is required per 100 sq. feet of flooring.

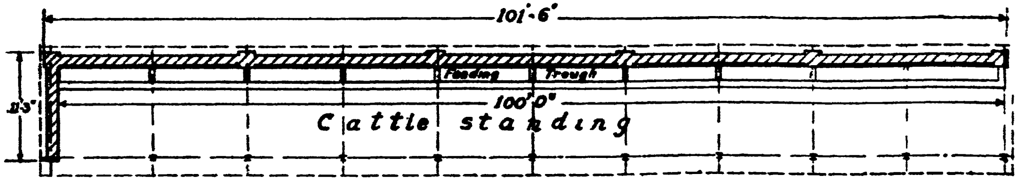
For a kutcha non-washable floor for cattle sheds, other than milking sheds, there is nothing better than hard-rammed red morrum.

Pucca-floored cattle or milking sheds should slope 1 in 48 from one end to the other, and the whole shed should be built on this slope so that the gripe or urine drain shall be the same depth at both ends of the shed. The best slope for the standings from trough to drain is 1 in 24, and the slopes of all dairy floors or other washable floors of any kind whatever is 1 in 48. No traps or drains opened should be allowed within dairy buildings, shallow saucer-shaped drains should be made in each room leading to a wall opening through which drainage could be conducted outside the building. Where a common drainage system does not exist, the best method of utilising dairy farm drainage of any kind is to use it for irrigation purposes for the growing of fodder. If a dairy farm has not sufficient water-supply to dilute its drainage to the point where it can be safely and economically utilised for irrigation of fodder crops, then that dairy has not a sufficient water-supply to carry on its business up to that standard of cleanliness which is essential and which the public have a right to look for. The choice of materials for walls, roof, etc., depends entirely on local conditions and the state of the purse of the builder. As the cost of dairy buildings must always depend upon the materials used, and as in a vast continent like India the cost of the same class of building material varies to a very great extent, it is impossible here to indicate even probable building costs.

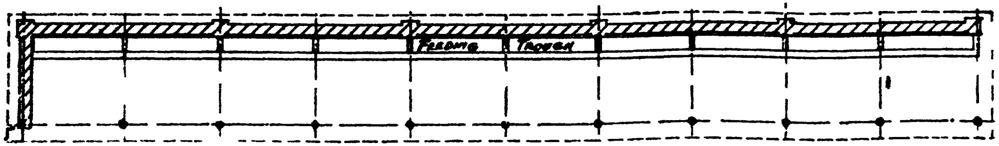
The question of architectural embellishment of dairy farm buildings has not been referred to in this note as the industry has not yet reached the stage in this country when it can afford any business of this kind.

Complete details as to dairy buildings of any class or for any purpose appertaining to the industry cannot be given in an article of this kind which can only serve as a general guide to prospective builders, but full and complete detailed plans of any class of dairy building can always be obtained free of charge on application to the office of the Imperial Dairy Expert, Bangalore.

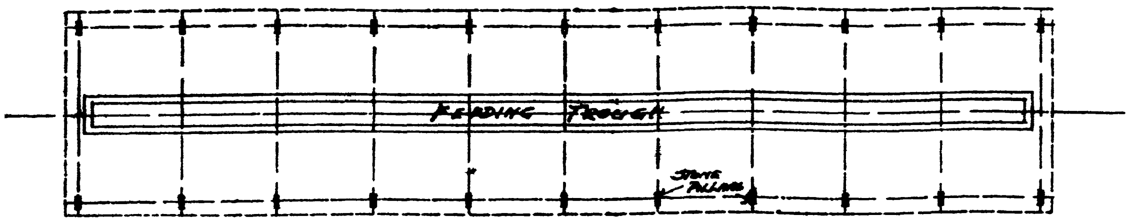
# PLANS 1, 2 & 3.



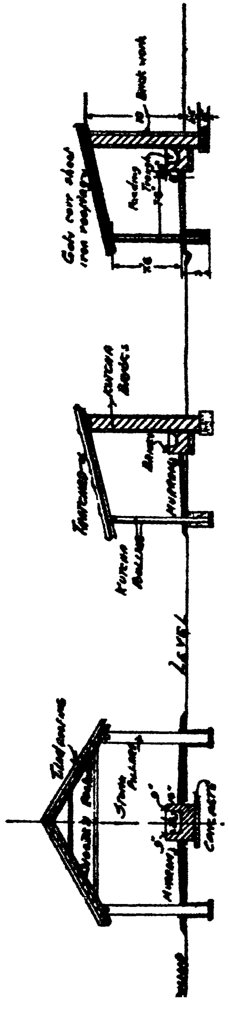

PLAN 1. PADDOCK SHELTER OF STEEL AND GALV. SHEET IRON.
Suitable for 25 Adult Cattle with Troughing & Murram Flooring.



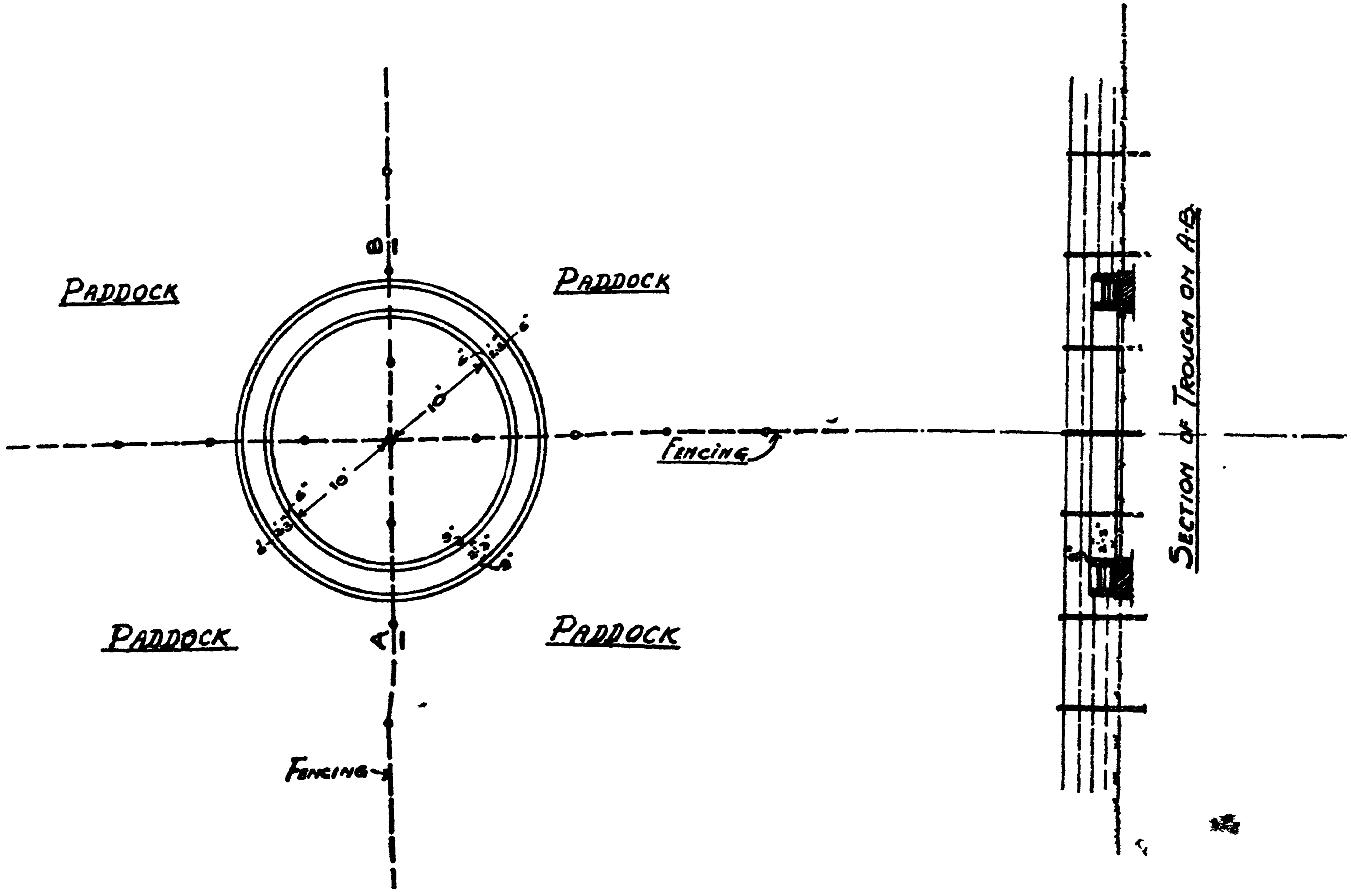

PLAN 2. PADDOCK SHELTER OF KUTCHA TYPE.
With kutcha bullies, thatched roof, and kutcha bricks.




PLAN 3. PADDOCK SHELTER OF SEMI-PUCCA TYPE.
Scale 20'=1".

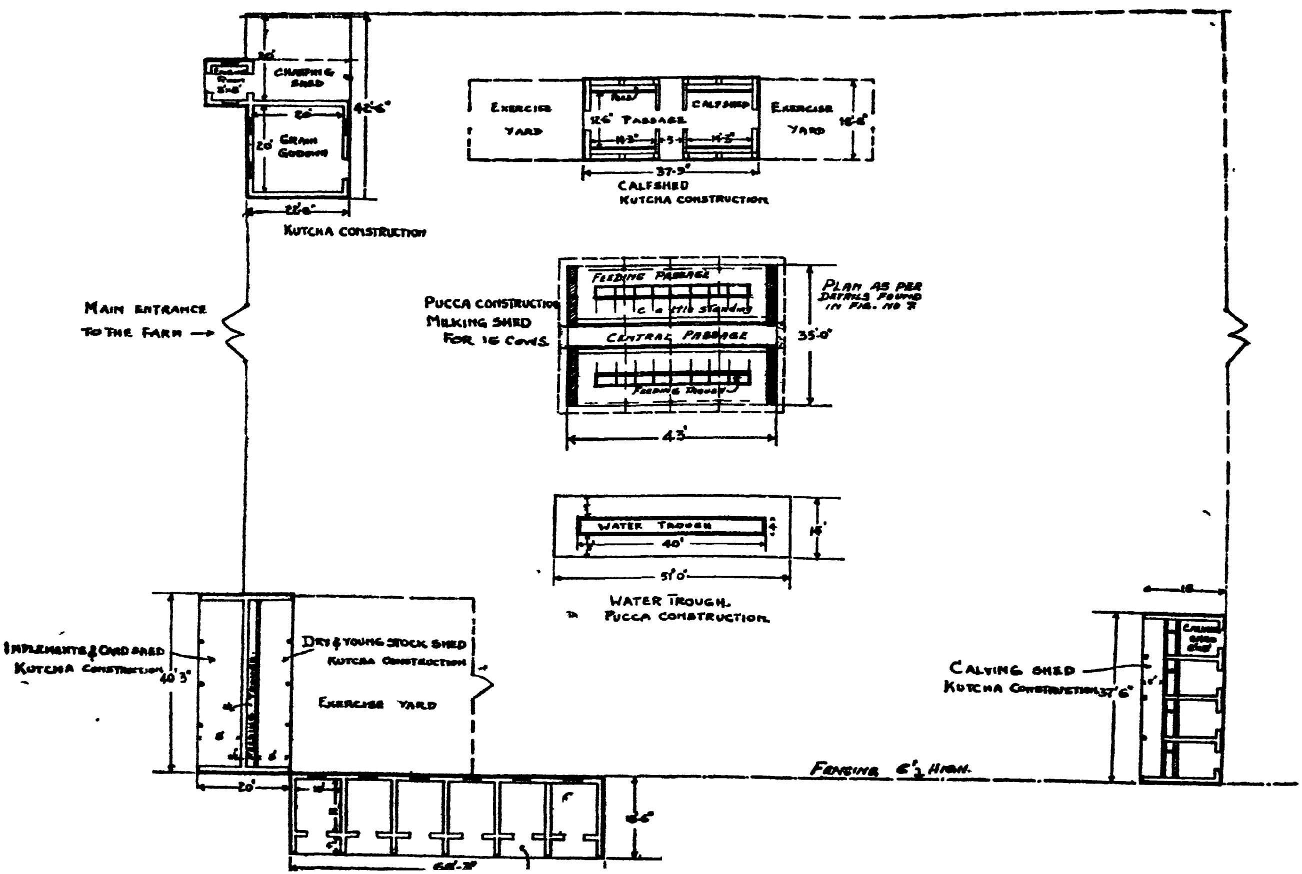


## PLAN 4. CIRCULAR WATER TROUGH.

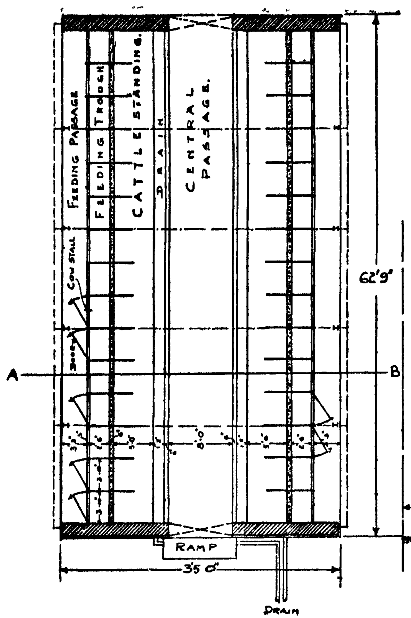


# PLAN 5. LAYOUT OF A SMALL DAIRY FARM.

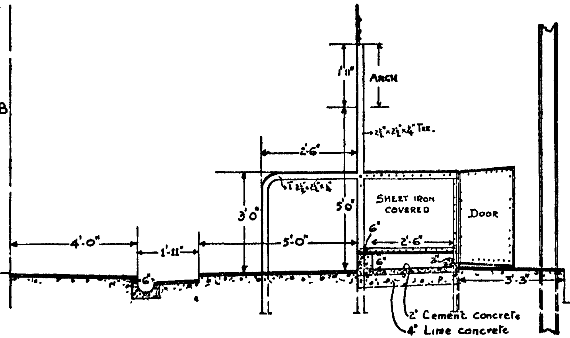
SCALE ⅛″=20′.



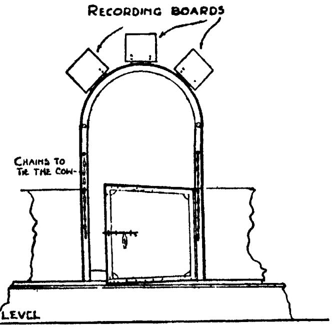
# PLAN 7. 'COLONIAL MILKING SHED.'




DETAILED DRAWING OF COW STALL.

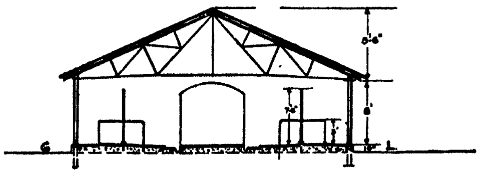



SECTIONAL ELEVATION OF HALF PORTION.



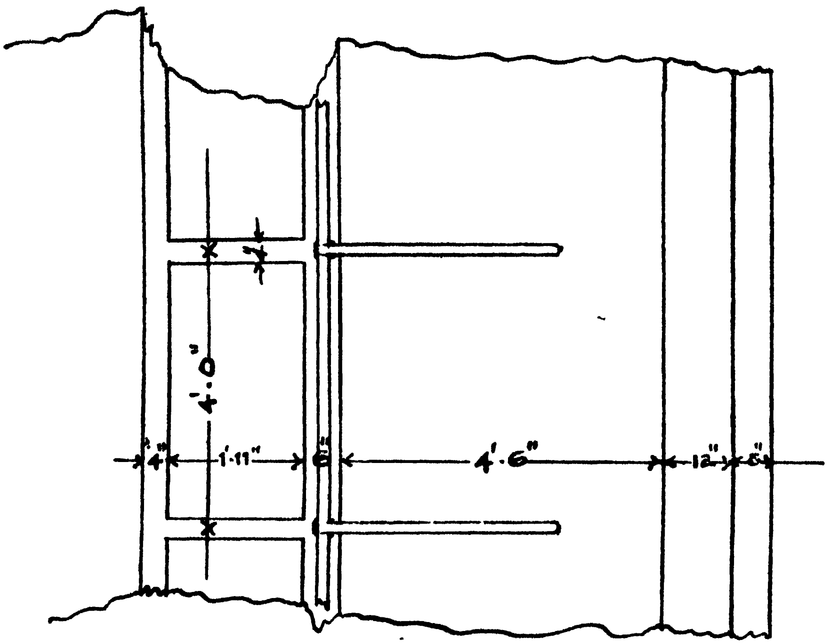

ELEVATION AT REAR.

Scale 4'=1".

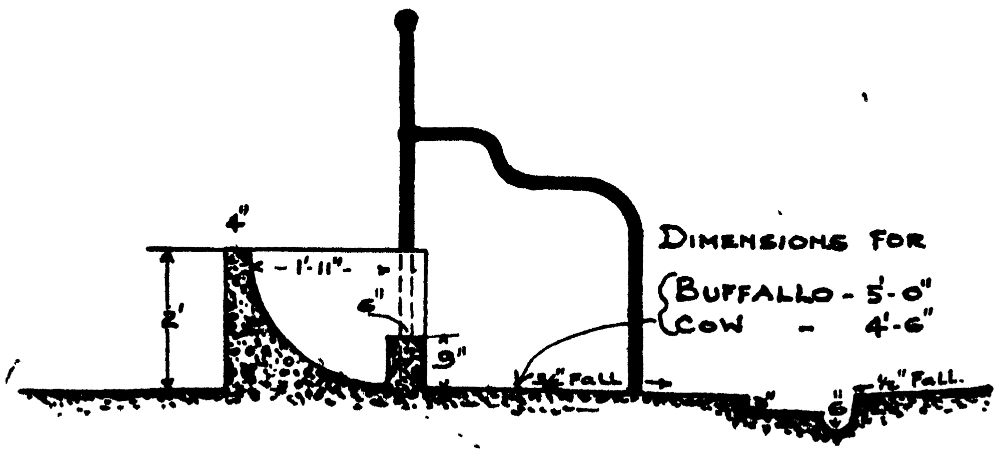



SECTION OF SHED ON A·B.

PLAN No. 8.



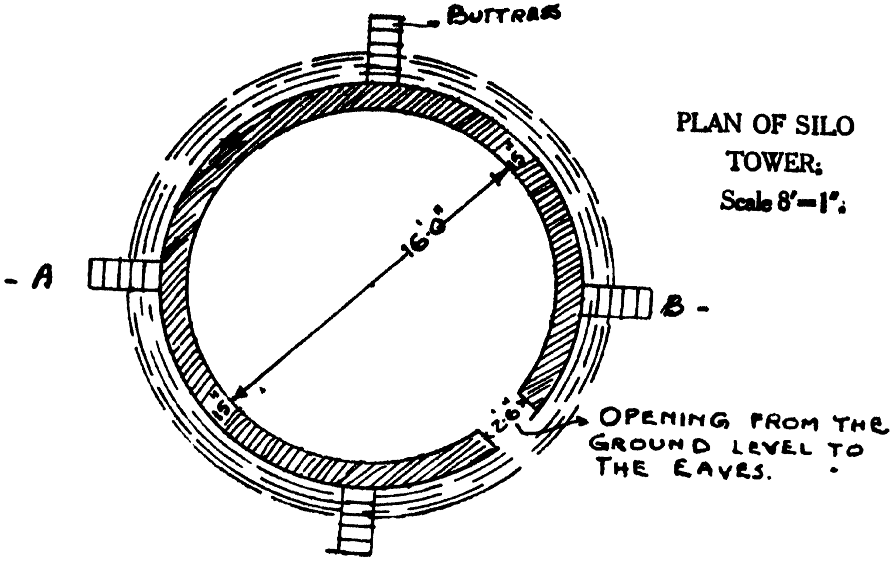

PLAN OF FEEDING TROUGH



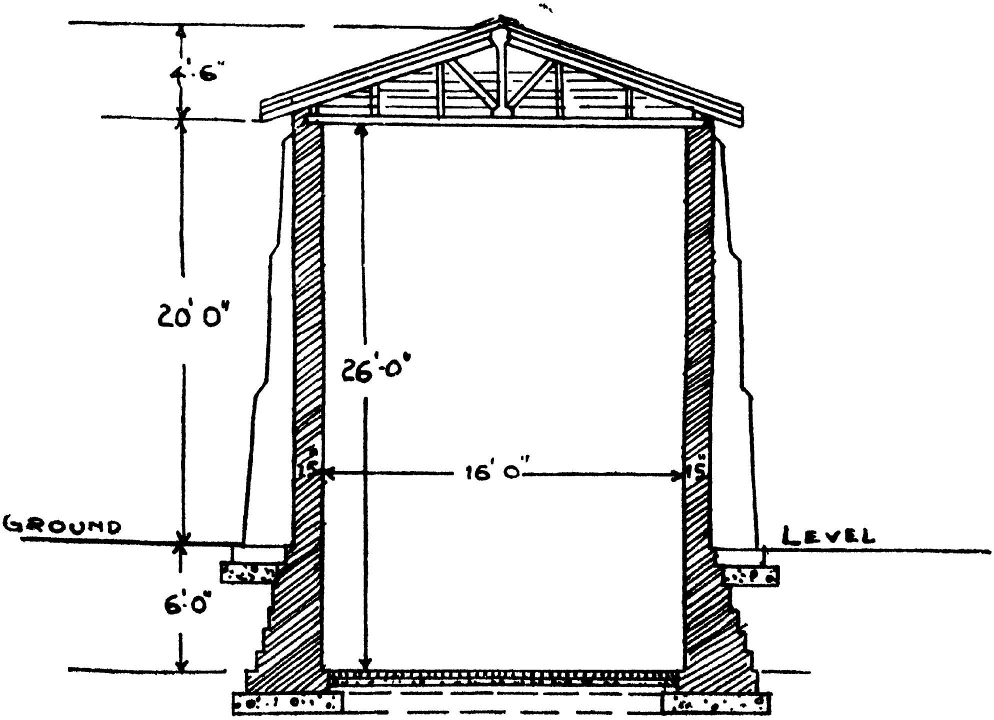

SECTION OF TROUGH.

Scale ⅜"=1'.

## PLAN 12.

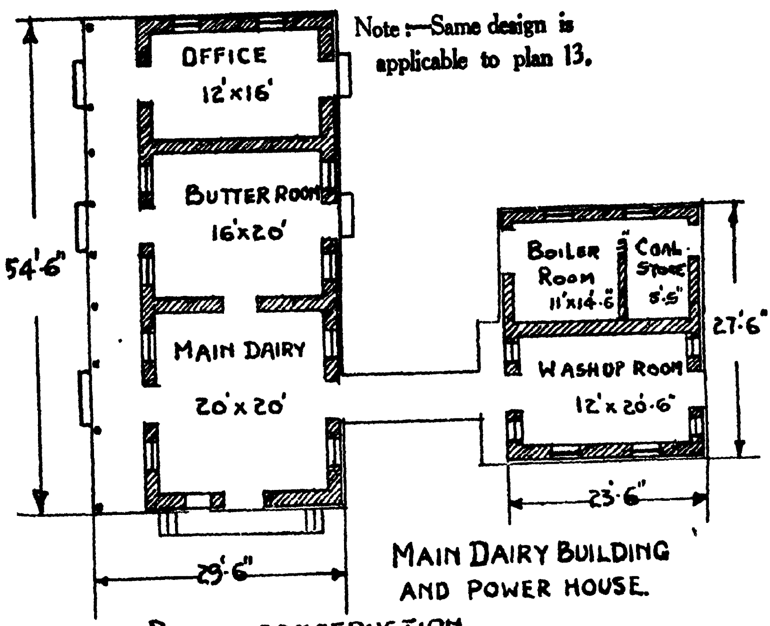



PLAN OF SILO TOWER.
Scale 8'=1".




SECTION ON A·B

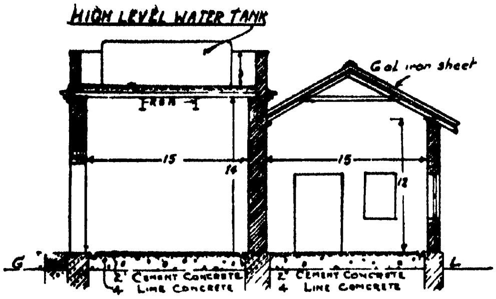
## PLAN 13.




MAIN DAIRY BUILDING AND POWER HOUSE.

PUCCA CONSTRUCTION.

Scale 10'—½".




CROSS SECTION ON C D

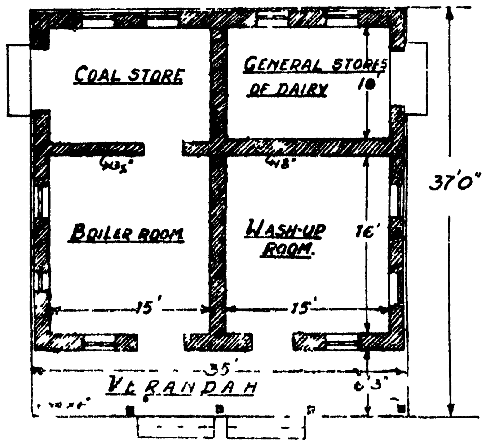
# PLAN 14.

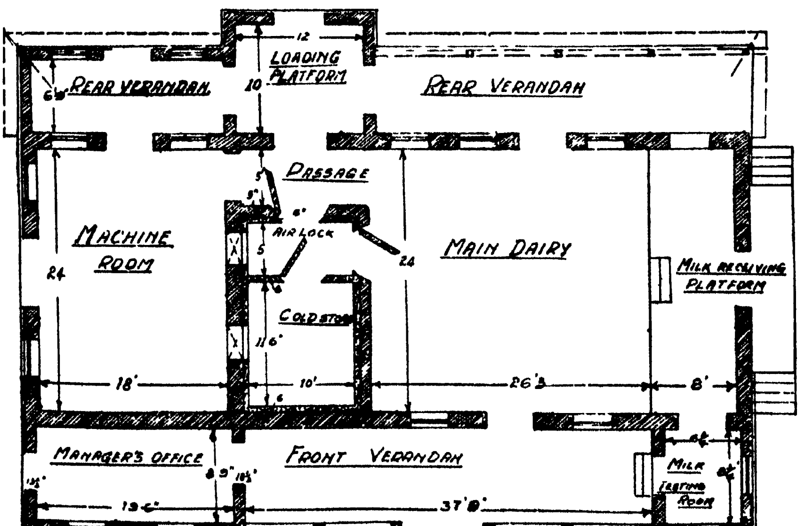
## PLAN OF DAIRY BUILDING A POWER HOUSE.

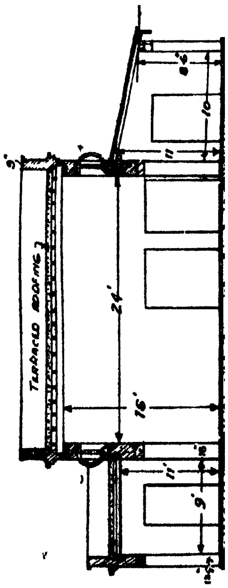
Scale 16′=1″.

Note :—Same design is applicable to the building as sited in Plan 6.

## PLAN OF POWER HOUSE, ETC.




PLAN OF DAIRY BUILDING

# THE PROBLEM OF RICE-BREEDING.

**(With special reference to Bihar and Orissa conditions)**

BY

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The actual methods of plant-breeding are now fairly well established, but the most important problem that confronts us is to determine the line on which future breeding work should be carried out on a particular crop. None can deny the fact that the first step towards the progress of agriculture in any country, and especially in India, centres round plant-breeding, *i.e.*, breeding of improved types of crop seeds which would give higher yield and prove better in quality as compared to the existing varieties grown by the ordinary cultivator. In India the poor cultivators are not in a position to take up the modern implements for improved cultivation, or to invest large capital on judicious manuring, etc. For the most part they depend on the improved varieties of crops provided to them by the Agricultural Department, but even this they are not prepared to take up until they have satisfied themselves as to the higher yielding capacity of the improved varieties. This necessitates a very careful and detailed study of the crops to be handled and to note the minutest characters which may in some way or other add to their yielding capacity.

Rice is one of the oldest and most important cultivations in the world It forms the staple food of most of the Eastern countries, *e.g.*, China, Japan, India, Malaya, Java and others. The part that this crop plays in the agricultural economy of this country is evident from the fact that it occupies about one-third of the total cropped area in British India. The area under rice alone is over 80 million acres, out of which nearly 50 per cent. goes to Bengal (22 millions) and Bihar and Orissa (15 millions) alone. The other provinces that grow rice to any large extent are Burma (11 millions), Madras (11 millions), United Provinces (7 millions), Assam (4·5 millions) and Central Provinces (5 millions). It is hence evident that the importance of this crop is not restricted to one or two provinces, but it is grown on large scale practically all over India. It forms the staple crop in at least five provinces, namely, Bengal, Bihar and Orissa, Assam, Burma and Madras. This in itself is enough to justify any careful consideration for the improvement of this crop. But the pity is that the yielding capacity of the Indian rices is far

below that of any other rice-growing country as evident from Table I given below :—

TABLE I.

*Area and yield of rice in the more important rice-growing tracts.*

| Serial No. | Countries | Area in acres | Yield in lbs. | Yield per acre in lbs. |
|---|---|---|---|---|
| 1 | Argentine . . . . | 23,750 | 48,160,000 | 2,027 |
| 2 | Bulgaria . . . . . . | 7,889 | 12,093,334 | 1,609 |
| 3 | Egypt . . . . . . . | 213,112 | 568,631,112 | 2,668 |
| 4 | Formosa . . . . . . | 1,224,556 | 2,000,071,112 | 1,633 |
| 5 | Indo-China . . . . | 11,266,556 | 11,326,933,334 | 1,005 |
| 6 | Italy . . . . . . . | 317,667 | 1,113,777,778 | 3,506 |
| 7 | Japan . . . . . . . | 7,633,333 | 23,003,057,778 | 3,014 |
| 8 | Java and Madura . . . . | 7,976,250 | 10,514,870,000 | 1,318 |
| 9 | Korea . . . . . . | 3,806,500 | 5,742,240,000 | 1,509 |
| 10 | Siam . . . . . . . | 5,045,000 | 9,706,848,000 | 1,936 |
| 11 | Spain . . . . . . . | 111,667 | 574,684,444 | 5,146 |
| 12 | United States of America . . | 997,556 | 1,737,742,222 | 1,742 |
| 13 | India . . . . . . . | 80,105,000 | 70,310,016,000 | 878 |

The above table clearly points out that the yield obtained in India is the lowest as compared to other rice-growing tracts. India gives an yield of less than 1,000 lbs. per acre, while Japan, Spain, etc., produce 3,000 lbs. or more per acre. While the area under rice in Japan is less than one-tenth of that in India, the yield is only one-third.

It is, therefore, essential to improve the varieties of paddy grown in India and thereby increase its production, at least, to the level attained by most other countries. This could be accomplished only through careful breeding of new varieties, but unfortunately in India very little has so far been done in this direction. The pioneer workers on this crop in India have been Hector, Parnell-Graham and others, who have made a fairly valuable contribution to our knowledge of the genetics of this crop; there is still much to be done. None of these early investigators had been able to classify the different existing varieties of even

their own locality. The obvious reason for this had been the great diversity of forms that exist in this crop. The varieties of rice that occur in different localities are enormously large, and it is said that practically every district has its own varieties quite distinct from those of others. While it is highly probable that many of these different varieties may actually belong to the same botanical class, the total number of the varieties would still be very large. It is the duty of the plant-breeder to classify them on a systematic basis and establish distinct strains, which should breed true to the more important botanical and economic characters.

The first step towards the improvement of a crop lies in the establishment of pure strains (*i.e.*, isolation of pure lines) which form the material for any future improvement by hybridization, etc., and at the same time serve to meet the immediate requirements. The isolation of 'pure lines' does not in itself add anything to the quality of a crop, but it simply offers an opportunity to the careful observer to spot the more promising plants, some of which will establish themselves by keeping up the qualities that they were originally found to possess. The breeding in this case consists in carefully comparing genetically different types for a series of years and selecting those which appear to be promising from commercial as well as economic point of view. The improvement of a crop through "selection" is considered to be the simplest, but it presents the plant-breeder with greatest difficulties, instances of which will be quoted when specific problems are dealt with.

There is a great attraction in taking up the isolation of "Pure lines" in this crop, as all the hopes of a plant-breeder lie in the diversity of forms that occur in the material to be investigated, and paddy is undoubtedly the most promising in this respect. In this crop the variations are so profuse and distinct that practically all the requirements of the farmer could be met simply through the isolation of pure strains. Recourse to hybridization may not be needed at least for sometime to come. But this multiplicity of forms has its drawback as well, *i.e.*, the number of varieties is so large that any attempt at isolation of "pure lines" results in confusion and failure, as has been the case with many previous investigators. The only method, therefore, to accomplish this work successfully is to take up the isolation work in parts, *i.e.*, by establishing several sub-stations representing area with distinct soil and climatic conditions. The whole work could then be co-ordinated into one. This idea gets further support from the fact that the varieties of paddy grown in one locality with a particular type of soil usually do not suit others, which would mean that these varieties, even if they are botanically similar, must be agriculturally distinct and hence there is no justification in classifying them together.

The province of Bihar and Orissa presents its own peculiar conditions, which make it all the more necessary to establish several sub-stations for the breeding of paddy varieties. In this province we come across a great diversity in physical as well as chemical nature of the soil. The paddy tracts of Bihar represent conditions found in four different bordering provinces, *i.e.*, Central Provinces, Bengal, United Provinces and Madras. We find three distinct types of soil occurring in different parts of the province as given below :—

| | |
|---|---|
| (1) Red . . . | Chotanagpur and parts of Orissa. |
| (2) Alluvial . . . | North Bihar (North of the Ganges and parts of Orissa adjoining the sea). |
| (3) Older alluvial (hard calcareous). | In tracts adjoining Gaya. |

These soils further differ chemically, *i.e.*, the Chotanagpur soil is very acid, while the soil of Bihar proper is alkaline and that of Orissa is slightly acid.

With these variations in the soil conditions it is not possible to expect one particular strain to meet the demands of all the localities. The requirements of the plants in each of these tracts would naturally be quite different, and the varieties that have established themselves in one locality will hardly have any chance of flourishing in the other. It has actually been found that a particular strain evolved at Sabour serves well for the localities with similar soil conditions, but it absolutely fails when grown in localities with different types of soil.

This crop, however, presents many more difficulties than those pointed out in the preceding pages. A great problem in paddy is its limited adaptability, *i.e.*, one particular variety of paddy can grow well only under certain specific soil and moisture conditions, and if it is grown on a soil to which it is not adapted, the produce will be very poor. This limited adaptability is a great hindrance to any real improvement, as it necessitates keeping up of a number of strains for different localities and even for different soils, one for the rich land, another for poor and a third for the medium land. The keeping up of several varieties affects the improvement of rice production in two ways, *i.e.*, (1) selection work has to be carried out at more than one station, as pedigree selections suitable for one locality are not suitable for another, (2) the improved strains get intermixed and deteriorate in course of few years. The varieties grown on high land are liable to get intercrossed with those grown on medium lands, as these types of land occur side by side and the flowering period of some of the highland paddies may overlap with that of the medium ones.

In order to overcome the latter difficulty, the plant-breeder has to select only such different varieties for high, medium and low lands that the flowering period of one

does not overlap with that of the other. A search for highly adaptable variety of paddy must be the primary object of every rice-breeder. Once such a variety is established, many of the complex problems associated with this crop will at once be solved.

Another line of work that needs immediate attention is the **physiology of the rice-plant**—a subject on which we are practically in absolute darkness. Several workers are needed on this subject as the problems before us are innumerable. We are still groping in dark when we take up the problem of transplanting and its benefit to the paddy plant. Various theories have been put forward from time to time in order to explain this, but there are no definite facts to establish them. Some consider that the benefit of transplanting lies in the care and attention that the plants receive at the seedling stage, while others attribute this to the stimulus received on account of the root injury, which serves the same purpose as root-pruning. Still others believe in the favourable water-supply of the transplanted paddies. There may be some truth in each of them, but we must have facts and figures obtained through well-planned-out experiments before any of these theories could be taken as correct. The question of the growth and development of early, medium and late paddies under different soil conditions has so far received no attention. Innumerable questions that arise in this connection are still unanswered. The physiological explanation for the lodging tendency of the different paddy varieties and scores of other physiological problems need investigation.

The plant-breeder has further to study the behaviour of various rice strains when subjected to abnormal physiological conditions, such as shortened day-length, artificial illumination at night, delayed sowing and transplanting, etc. Such abnormal conditions may produce remarkable physiological response on some of the strains and induce conspicuous differences; occasionally these differences bear directly on practical growing or on breeding techniques.

It has been found in other crops that plants subjected to shortened day length induce early flowering. If this is established in paddy as well, it would be no mean achievement, as then we could use a very late paddy, possessing some desirable character, for crossing with an early one. Such a problem is facing us in Bihar and Orissa where some of the late paddies possess very strong straw, while an early paddy named "Dahia" is more on demand on account of its other desirable qualities. It is therefore necessary to combine these qualities in one, but so far such a crossing has not been successfully carried out on account of the great difference in their time of flowering. If once it is established that early flowering could be induced by subjecting the late varieties to short day length or to longer illumination, all this difficulty would vanish.

Such investigations on the physiology of rice plant are of great economic importance, and they promise a wide field for breeding improved varieties of not only rice but even those of other crop plants.

It has already been pointed out that the paddy crop consists of a large number of distinct varieties. With the **multiplicity of forms** it is natural to expect the crop to show innumerable variations in the various morphological characters, vegetative as well as reproductive. This is what we actually find in paddy and any classification of the cultivated varieties presents special difficulties and becomes a problem by itself. In breeding pure strains of any crop, the plant breeder's first attempt is to isolate "pure lines" and to classify them in a systematic way. Without such a classification, the real value of the pure strains could never be found. Now, the question arises what should be our **basis of classification**, while dealing with the cultivated varieties of a crop. Some of the previous investigators have suggested that more stress should be given to the grain characters which are more constant rather than to the agricultural characters showing a good deal of variation.

F. Koernicke [1894] in Japan has based his classification of rice on grain characters alone, while S. Kikawa [1912, 1] gives two schemes of classification for the rices of Japan, based (1) on agricultural characters and (2) on grain characters. Graham [1913, 1] in dealing with the rices of the Central Provinces, considers that the use of agricultural characters in a scheme of classification demands a considerable amount of caution, and he thinks that no hard and fast system of classification based on agricultural characters can be laid down. Recently, Sethi [1930, 1] in the United Provinces has laid much stress on the grain characters which he considers to be more constant. He has classified the rices of the United Provinces mainly on the grain characters, *i.e.*, size, shape and colour of grains.

The study of the large number of paddy varieties grown at Sabour and those in other parts of the province of Bihar and Orissa urges the present writer to differ from the above opinion and lay more stress on the scheme suggested by S. Kikawa, *i.e.*, the classification of rices should be based both on agricultural and grain characters. As this question is a matter of some controversy, it has to be discussed in some detail. It is not necessary to deal with each character separately, but only a few of the more important ones may be discussed and the advisability of including them in any scheme of classification, for economic purposes, will be pointed out.

Many of the **agricultural characters**, especially those based on presence and absence of *colour* are as constant or more so than some of the grain characters. The appearance of colour in various vegetative organs have been found to be dependent on definite Mendelian factors—a detailed account of which has been given by

Hector [1916] and Parnell [ 1917] for the rices of Bengal and Madras respectively. Such characters which depend on definite Mendelian factors could, with absolute reliance, be utilized in classifying the cultivated rices. These characters are of special significance from practical point of view. The varieties showing distinct colors are easily recognized even by ignorant cultivators and if our improved varieties possess some such distinctive characters, they have greater chance of remaining pure than when they are indistinguishable from ordinary mixed crop, as roguing is easily done in the former case.

The character of the *awn* is another agricultural character which is of great practical importance. It has been pointed out by Graham [ 1930, 2 ] that the length of awn varies within the same variety and is by no means constant, while Sethi [ 1930 2 ] from his study of the rices in the United Provinces, concludes "No feature is more variable among the rices grown in these provinces than the awn character'. The length varies in different varieties and even within the same variety the length of the awn is by no means constant ". The present writer, however differs from both these authors on the basis of the observations made on the rices of Bihar and Orissa. A certain amount of variation does occur in all characters, quantitative or qualitative, but on careful study we can easily distinguish the environmental from the varietal differences. The paddy varieties grown at Sabour are found to vary a good deal in the character of awn, *i.e.*, some of them are awned, others are simply tipped and still others are perfectly awnless, but the same strain, if botanically pure, will not consist of fully awned, tipped and awnless ears. The more remarkable variation in awn character is not due to environment but due to heredity. It has actually been found from the results of a few natural crosses that the appearance of awn depends on the interaction of two distinct Mendelian factors. In the Botanical Experimental Area, Sabour, various grades of awns were noted this year in cultures splitting for this character but only three distinct classes could easily be made, *i.e.*, bearded, tipped and awnless.* The

frequency of each of these classes in two of the splitting cultures were as given below in Table II.

TABLE II.

*Segregation of awn character in a natural cross of paddy.*

| Culture No. | Awn character of the parent | Segregation in awn character | | | Total |
|---|---|---|---|---|---|
| | | Bearded | Tipped | Awnless | |
| 166 | Tipped . . | 8 | 16 | 2 | 26 |
| 167 | Do . . | 12 | 24 | 3 | 39 |
| Total observed | frequency . . | 20 | 40 | 5 | 65 |
| Expected . . . . . . | | 20·31 | 40·63 | 4·06 | 65 |
| Ratio . . . . . . . . | | 5 | 10 | 1 | .. |
| | | $\underbrace{\quad 5 \quad 10 \quad}_{15}$ | | : 1 | |

By combining the bearded and tipped classes together, we get a 15: 1 ratio of awned and awnless plants. From these facts it appears that the inheritance of awn character in rice is very similar to that obtained by Howards [ 1912 ] for wheat. The bearded class in the above table probably includes the fully, nearly fully, and half-bearded conditions noted by Howard while the tipped class includes the long and short tips which were classed together even by Howards. A more complete genetical analysis of the inheritance of this character in rice could, however, be made only after "pure lines" are established and actual crossing of awned and awnless strains is carried out. But the results of natural crosses do establish. at least, this much that the appearance of awn in rice is dependent on two Mendelian factors. This gets further support from the fact that a number of strains have been isolated at Sabour that are pure for tipped condition, in addition to those that are pure for fully bearded and perfectly awnless conditions. The awns further vary in their colour and distinct varieties with different awn colours can also be recognized.

The practical utility of basing our classification on this character is also of no less value. Certain localities where wild animals (pigs) or birds damage rice crop to any great extent, it becomes necessary to evolve awned varieties for such places as the presence of awns keeps the pest away. But, as a rule, the awned varieties are not liked as they give a disagreeable feeling to the workmen when it comes in contact with them, and it is also found that the awned varieties show a tendency

towards the shedding of grains soon after ripening, which is a highly undesirable character. It is on this account that most of our present cultivated rice varieties are awnless.

*Time of ripening* is another very important agricultural character, but Graham considers that a classification based on this character is unsatisfactory as there is good deal of variation in period of ripening from one locality to another.

Of course it is impossible to classify the rices of the world into early, medium and late groups, and even in one country with considerable difference in climatic conditions, no hard and fast classification based on this character could be made, but particular varieties when found to be early, medium or late in one district are sure to be comparatively the same in another. This would better be explained by taking a specific example. In Bihar "Dahia" has been found to be an early variety, on the basis of the observations made at Sabour, while "Latisal" is found to be late. The former ripens in about 110 days while the latter in 130 days. It is possible that the same two varieties when grown at Gaya or at Kanke may need a greater or lesser period to ripen but the comparative earliness of "Dahia" shall never be lost.

A knowledge of this feature of the different cultivated varieties would be found very useful, because the requirements of early, medium and late-ripening paddy varieties are so different that the real value of a useful strain may be absolutely lost through sheer ignorance of its time of ripening. As an instance of this may be cited a very interesting case observed at Kanke Experimental Station where an early paddy named "Rais" was grown in comparison with "Dahia" for a year or two on comparatively high land and "Dahia" was found to be superior in yield. Later, these same varieties were grown on the highest land without any definite object in view, and it was found that this year "Rais" has proved to be decidedly better than "Dahia" in yield. It was then noted that "Rais" is about a week earlier than "Dahia". This experiment was repeated next year, and these two varieties were again grown both on the highest land and on the ordinary high land. The previous observations were confirmed, and it was found that the earlier variety, *i.e.*, "Rais", excelled "Dahia" on the highest land while "Dahia" excelled "Rais" on ordinary highlands. This shows how important it is for the rice-breeders to know the time of flowering and period of ripening of the different varieties of the cultivated paddy. Even slight variations in time of ripening demand difference in the type of land for growing them.

Another instance of the practical utility of studying the time of ripening and classifying varieties on this basis may be cited from Japan where the early-ripening strains isolated have provided a type that alone would suit the cooler northern part

of the country (Hokkaido). These early strains have not only insured the success of the crop in these parts but also helped to increase the acreage under cultivation. It has further made it possible to grow rice in tracts further north than Hokkaido where its cultivation has never before been dreamed of.

*Resistance to drought and flooding* is an agricultural character of great practical importance. Distinct varieties of paddy have been found that can stand various periods of drought extending to even a month, while on the other hand, there are varieties that can withstand flooding for shorter periods. Such distinct varieties when once established are of great economic importance, and it is impossible for a plant-breeder to neglect such characters however varying they may be.

There are several *size characters*, such as height of the plant, length of the peduncle, number of the flowering branches in an inflorescence, size of the spikelets, etc., which generally show considerable amount of variation from plant to plant, but still they could safely be utilized in a scheme of classification as they do show certain amount of constancy from variety to variety. The practical utility of classifying the paddy varieties on the basis of these characters consists in the correlation that sometimes exists between these characters and some others that are of great economic significance, *e.g.*, lodging tendency, shedding of grains, yielding capacity, etc. It has been noted at Sabour that the varieties with tall stem show a tendency to lodge and similarly those with broad leaves possess coarse grains. Once such correlations are established, selections for non-lodging strains could easily be made on the basis of vegetative characters alone at a much earlier stage.

*Height of the plant* is also of some practical utility. Kikawa [1912,2] has found definite correlation between the length of stem and the number of tillers formed, *i.e.*, taller plants form fewer tillers. Correlation also exists between the length of stem and average weight of the ear. These correlations have been noted even in the varieties grown at Sabour. Apart from the ordinary "tall" varieties we occasionally find "extraordinarily tall" rices that are of special use in fields which may often be covered with deep water in consequence of river inundations—a condition commonly met with in parts of Orissa.

In addition to these characters considered in the preceding pages, we come across many other agricultural characters such as habit, lodging tendency, tillering capacity, number of panicles and spikelets which are of no less importance, and they have all been taken into account by the writer in studying the rices of Bihar and Orissa. Certain strains have been isolated that stand erect throughout their growth period, while others lodge badly in the fields as shown in Plate XXXVI, figs. 1 and 2. Similarly we have been able to isolate strains that show a closed

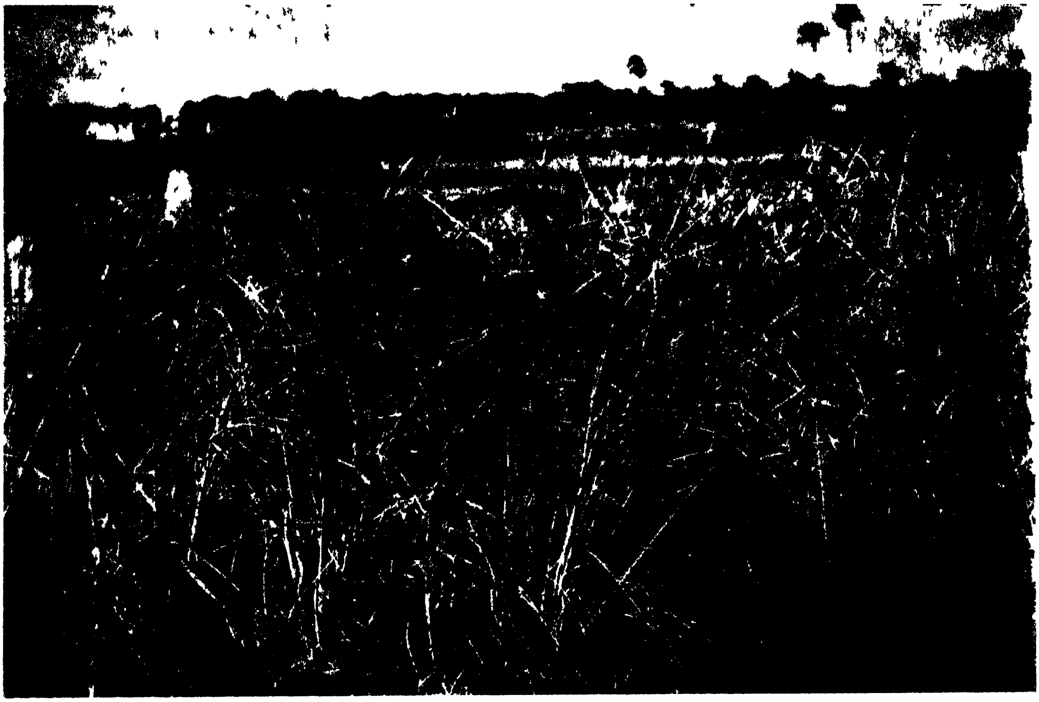

Fig. 1.—A strain of paddy just before harvesting All plants of this strain stand erect till the harvesting time

Fig. 2.—Another strain of paddy just before harvesting. Here all the plants have lodged badly several weeks before harvest.

PLATE XXXVII

Fig. 1.—A paddy strain showing an erect or "closed" habit.

Fig. 2.—Another strain showing its spreading nature, *i.e.*, "open" habit.

habit while others possess a spreading tendency, *i.e.* open habit ( Plate XXXVII, figs. 1 & 2). All these characters show a certain amount of variation but within a pure strain, they are more or less constant.

The natural conclusion that could be drawn from the above discussion is that the agricultural characters of the paddy plant, though less constant, are as definite and as much of practical utility as the grain characters and any scheme of classification of the cultivated rices that disregards these characters is imperfect and incomplete.

S. Kikawa [1912, 3] after studying the rices of Japan, India, Burma, Ceylon, Java, etc., has arrived at a similar conclusion, and he thinks that in classifying the cultivated plants we would of course consider their morphological characters which are constant, but at the same time we have also to examine those characters which though not very constant, or fluctuating considerably, are sometimes very important for agricultural purposes.

So far very little genetic investigation on the agricultural characters of paddy plant has been carried out in India, but it has been reported by Dr. Hirosi Tarao [ 1926 ] from Japan, where genetical researches have been carried out on such characters as time of heading (flowering), time of maturing, length of stem and panicles, intensity of tillering, quality and type of grains, formation of awns, disease resistance, pigmentation on grains, vegetable parts, etc. It has been found that the characters bearing directly on such practical aspects as yielding ability, grain type, maturing date, disease resistance, adaptability for intensified culture, etc., are as a whole demonstrated by numerous Mendelian factors.

Such investigations establish that even the fluctuating characters like time of heading and that of maturing or the length of stem and panicles, intensity of tillering, etc., are determined by the presence or absence of definite Mendelian factors and point out the great possibility that lie for the plant-breeder to classify the cultivated crops on the basis of agricultural as well as grain characters and thereby isolate types that would suit the varying condition of soil, moisture, etc. The modern tendency is to base our future classification on genetical basis after a complete genetical analysis of a crop has been made. This would undoubtedly be the most perfect classification and would certainly include many of the agricultural characters within its scope.

This discussion on the basis of classification of the cultivated rices has not only established the importance of agricultural characters, such as early ripening, drought resistance, lodging tendency, tillering, etc., apart from the grain characters which undoubtedly must also be taken into account, but also as a side issue has pointed out some of the most important rice-breeding problems that need our

immediate attention. The preceding discussion would therefore be of some value from both these points of view.

One aspect of the rice-breeding problem has so far received very little attention, *i. e.*, the question of **appropriate spacing.** One particular practice of planting paddies, *i.e.*, 6" to 9" apart, with two or three seedlings at the same place, has been in vogue for centuries and still continuing in most rice-growing tracts of India. This problem, however, needs a thorough investigation so as to find out the spacing which would give maximum yield within a limited area. This much has been noted at Sabour that greater spacing than 9" results in better tillering, but we have to find out the most profitable one. In Malaya, Dr. Jack has proved that the wider planting distances produce the largest crop. With even 12" to 18" spacing, depending on the fertility of the soil, tillering is profuse and yields are satisfactory. In Ceylon, however, Lord [1928] considers that heavy tillering is not desirable as large number of tillesc result in uneven flowering and maturing of individual plants and if the later tillers are allowed to mature before harvesting the crop, the panicles of the main culms commence to shed their grains. In the province of Bihar and Orissa this happens only in certain special varieties but as a rule no such difficulty is encountered. This aspect of the question has, however, also to be borne in mind whenever profuse tillering is encouraged.

It is therefore necessary to conduct researches for the analytical studies of the **tillering** of rice and the influence of manuring intensity, transplanting time, spacing, etc., on the development of tillers. Such study is sure to point out the ways and means for increasing the yield of even the best-yielding types that exist at present.

One of the most serious hindrance to the spread of scientific improvements in plant-breeding is the indifference of agriculturist to the **question of varieties and of marketing.** Although India is the biggest rice-growing country, the export of

this crop is limited only to Burma which is responsible for about 85 per cent. of the export of rice from India as is evident from the following table :—

TABLE III.

*Production and exports of rice from India.*

(Million lbs. of white rice.)

| Year | Burma | | Bengal | | India | |
|---|---|---|---|---|---|---|
| | Production | Export | Production | Export | Production | Export |
| 1921-22 . . | 10,356 | 3,909 | 20,760 | 289 | 74,240 | 4,454 |
| 1922-23 . . | 10,317 | 3,689 | 20,270 | 601 | 75,495 | 4,540 |
| 1923-24 . . | 9,334 | 4,138 | 16,820 | 759 | 63,164 | 5,106 |
| 1924-25 . . | 11,350 | 4,085 | 17,273 | 442 | 69,601 | 5,511 |
| 1925 26 . . | 10,624 | 4,021 | 18,408 | 266 | 68,627 | 5,226 |
| 1926-27 . . | 11,451 | 4,383 | 15,475 | 261 | 66,506 | 4,967 |
| 1927-28 . . | 10,945 | .. | 14,531 | .. | 62,658 | .. |

An investigation into the marketing problems of rice is an immediate necessity. In places where rice is practically the only crop grown, the cultivators have to depend on this crop for their food as well as for other amenities of life which they must get by marketing their surplus produce. Once the marketing problem is settled, we have to improve the quality of our produce. The breeding of a crop for quality very often presents innumerable difficulties and it necessitates the evolution of a fairly large number of suitable varieties which must be tested by the consumers on a large scale before they are finally considered as successful.

This is an established fact that all the cultivators' as well as breeders' primary object is to obtain higher yielding varieties, but in most crops we still do not know what are the factors that determine yield. Yield itself has not been so far analysed. Is the plant-breeder to aim at a plant producing many tillers or few ? Is he to lay more stress on the total produce of plant, or on the yield of each tiller, *e.g.*, in paddy are we to select plants on a basis of yield per plant or on yield per panicle ? In some cases two grains are formed in each spike. Is it more profitable to grow such varieties or to improve the yield of ordinary single-grained varieties by other

means? Scores of such questions arise when we consider the yielding capacity of a crop. Unless the plant-breeder has answered these questions, he can not add very much to the yielding capacity of his selections. It may be argued that it is useless to land ourselves into such complex problems and that the safest course would be to find the actual yield of the improved varieties and select the best-yielding ones without bothering ourselves with the innumerable factors that control it. But a plant-breeder would not stop at this. His object is to derive the maximum possible benefit from the opportunities offered to him by nature. It is possible that on comparing a number of varieties, we may find one which would supersede all the rest in yielding capacity, but we can never assume that all further improvements stop there and all the factors that determine yield are possessed by that particular variety. It may be wanting in several of them and if they could be investigated, the plant-breeder can devise ways and means to add those factors as well to his best type and thereby increase its production to a greater extent.

In order to investigate the factors that control yield, it is necessary to carry out an intensive study of the crop, *i.e.*, to study such characters as the number of tillers, length of panicles, number of primary branches of the panicles, number and weight of grains formed in each panicle and such other characters which may have a direct or indirect effect on the yield of a plant and then to correlate these characters with one another and with the yield of each plant.

Apart from the factors that add to the yielding capacity of a plant, there may be other factors that diminish yield—the most important of which is *sterility*. The various forms of sterility that occur in our crops and fruit trees have been fully dealt with by the writer [Alam, 1929] in an earlier publication and need not be repeated here, but a reference to its occurrence in paddy may be made. It is common to note number of empty glumes in the ears of several of our paddy varieties but it is more remarkable in certain strains than in others. These empty glumes may be the result of unfavourable weather conditions during flowering, but in such cases the empty glumes occur in plants all over the field and not limited to a few plants in certain varieties alone. The more common cause for occurrence of sterile or semi-sterile ears in paddy varieties is the imperfect development of anthers or ovary, as has been actually found to occur in some varieties at Sabour. Such cases of sterility where the defect lies in the development of pollen grains, etc., are generally internal to the organism and are determined by definite hereditary factors. It is hence the duty of every rice-breeder to select only such strains that are free from these sterility factors.

The diverse problems that have been discussed in the previous pages could generally be solved in two ways. One is the pure-line selection method—a reference to which has already been made in the beginning—but through this we can achieve

only such improvements as have been provided to us by nature herself in the mixed crops. We can, however, look towards the second method, *i.e.*, hybridization, as the panacea of most evils, and it can provide us with a much wider field for future improvements. Once we know exactly what are our requirements, hybridization will mostly crown us with success, but it would require patience and perseverence. Hybridization further gives us an insight in to the genetical constitution of the crop, which is in itself a great achievement to the plant-breeder, who can with its help plan out his future line of work for crop-improvement on a more rational and systematic basis.

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# THE WORK OF THE BOMBAY COTTON-BREEDERS

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The real and lasting benefits of applied science are nowhere more striking than in the realm of plant-breeding. The present paper is an attempt to give a short sketch of the work of a group of plant-breeders working in one province and on one crop. The outward and visible evidence of their success is the existence of certain cotton varieties which are now widely spread in the areas to which they are suited and which are known and valued by the buyer, the broker, the shipper and the spinner.

Bombay has always been an important cotton province and on an average the Bombay cotton area (inclusive of Sind and Indian States) represents 29·2 per cent. of the total area under cotton in the whole of India. The Bombay cotton area was 6,042,000 acres in 1930, the maximum figure, however, was reached in 1925 when the area under cotton was 8, 011,000 acres. The cotton grown in Bombay is by no means of one type. Owing to the extension of the province proper from south to north through ten degrees of latitude, and with the still more northerly extension of Sind, through another four degrees, the territory under the Bombay Government shows an extraordinary range of variation in every conceivable subject of study, whether climates, peoples, languages, soils, or crops. The presence of the Western Ghats determines a most peculiar distribution of rainfall, while Sind is, as regards the growing of crops, dependent on irrigation. Naturally the varieties of cotton in such surroundings are also diverse, and the growth of the Agricultural Department has resulted in the appointment of one cotton-breeder to each of the characteristic cotton tracts. These are the Southern Maratha Country, the Khandesh Area, South Gujarat, North Gujarat and Sind.

But this is a recent development and in the beginning there were one or at most two scientists making a beginning at the investigation of cotton problems for the whole province. Among these special mention must be made of Mr. G. A. Gammie. He was Economic Botanist to the Government of Bombay and later (from 1908 to 1920) held the post (now abolished) of Imperial Cotton Specialist. He devoted himself to a thorough systematic study and classification of the Indian cottons, which he embodied in one of the very early Memoirs of the new Department of Agriculture in India. This Memoir is still a useful compendium, but a new

account of Indian cottons is long overdue. Mr. Gammie also began the work of the Department in selection and hybridisation of cottons. From one of his crosses there was later developed the race known as 1027 A L F, which is the longest stapled Indian cotton and has become famous in Gujarat. From 1903 to 1907 Mr. T. B. Fletcher, then Deputy Director of Agriculture for the whole Presidency, looked after cotton work on several experimental farms, and made further selections, incidentally carrying 1027 A L F towards its present condition. He was followed by Mr. T. F. Main (now Director of Agriculture, Bombay Presidency, then Deputy Director) who went on with the work of cotton-breeding from 1907 to 1915.

The breeding of cotton was then in each area put in the hands of a special officer under the direction of the Deputy Director. These special officers were at first called Cotton Supervisors and later Cotton Breeders. In the Southern Maratha area, Mr. S. V. Shevade, L. Ag., held the appointment from 1908 to 1912, when his assistant Mr. (now * Rao Saheb) G. L. Kottur, M. Ag., was appointed and still holds the post. At Surat, in Gujarat, the duties of the post were discharged by Mr. K. D. Kulkarni who also had charge of the work in Dhulia, Khandesh. Mr. Maganlal Patel, M. Ag., the present cotton breeder, South Gujarat, succeeded him in 1914. Mr. D. P. Mankad, Cotton Breeder, North Gujarat, was appointed in 1921, and Mr. S. H. Prayag, M. Ag., Cotton Breeder, North Central Division, Dhulia, took up his duties in 1921. In Sind, Mr. K. I. Thadani, B. Ag., M. Sc., was first Cotton Breeder and then Cotton Botanist, being succeeded as Cotton Breeder by Mr. B. B. Desai, M. Ag. The work grew rapidly and in the later stages general control was exercised by the Director of Agriculture, sometimes directly and sometimes through departmental research committees. More recently the research work of the Department has been discussed annually in a departmental body called the Crop Research Committee and the Economic Botanist has been allotted the task of supervising and advising all plant-breeders (including cotton-breeders) as a sort of general staff officer for applied genetics.

A brief account of the nature of the problems in each area and of the successes achieved will now be given.

### I. The Southern Maratha Country.

This area, which comprises the districts of Dharwar, Belgaum and Bijapur has two main and distinct types of cotton. One is the Kumpta type (called after the coast town of Kumpta from which this cotton used to be exported), an Indian cotton of the species *Gossypium herbaceum*. The other is called "Dharwar-American" and belongs to the species *G. hirsutum*. It is a curious remnant of attempts made about the year 1840 to acclimatize American

* The title was awarded in 1930 as a recognition of his work in applied genetics.

cottons. It is perhaps not accurate to call it a remnant, for the total area under Dharwar-American has been about 400,000 acres annually since 1869. The reasons for its success are that it has a high yield and a long staple and suits certain classes of soil not specially good for Kumpta cotton. The early work of the Department in connection with cottons involved a good deal of crossing of various types, and the attempt to acclimatize other cottons. As genetic knowledge grew and a definite doctrine of plant-breeding began to be developed througout the world, its effects were marked also in the plant-breeding policy of the Bombay Department, and in 1912 crossing was temporarily suspended and attention concentrated on selecting useful types from the forms both pure and hybrid then available. Mass selection was discontinued, and pure line selection was undertaken. To Rao Saheb Kottur belongs the credit of inventing the simple device of a wire ring for self-fertilising cotton on a large scale. From the Kumpta type of cotton the Breeder's first striking success was a race called Dharwar I, which held the field for a long time and would hold it still but for the wilt trouble. However, that also was overcome. But to return to Dharwar I: from the time of opening of the Dharwar Farm (*i. e.*, in the year 1904) selection had been done on the local Kumpta cotton. This was mass selection done specially for long and fine staple. The variety resulting from this selection was continued till 1910 under the name Kumpta 0 4Q III. It was then found to be varying considerably and pure line selection was begun in order to reduce this variation, eleven plants being so selected. The progenies were found to be still variable, some of them being inferior to ordinary Kumpta. In 1909-1910 Mr. S. V. Shevade made another selection for high ginning. In 1911-1912 selection was continued in Kumpta 0 4Q III, and in the following year the progeny of plant No. 3 was found to be pure and was selected by Rao Saheb Kottur. From this the strain known as Dharwar I was derived.

This variety, which at the height of its popularity covered 160,200 acres in the Southern Maratha Country, belongs to an erect type having only from one to three monopodia. An average of its performance as against local Kumpta for 15 years is as follows:

Increased yield 10 per cent.; increased ginning percentage 3 per cent.; and increased value per candy of lint (784 lbs.) Rs. 20.

From 1920, wilt trouble (due to the soil fungus *Fusarium vasinfectum*) became serious, and Dharwar I showed itself susceptible. This was a very serious situation indeed. It so happened however that beginning in 1913-1914 the Cotton Breeder had isolated another race (No. 61·1, later called Dharwar II) for high ginning, and this variety proved to be very wilt-resistant, the order of difference being (as an average of eight years) 50 per cent. in Dharwar I and only 2 per cent. in

Dharwar II, the number of plants under observation being from 200 to 300 annually, and the tests made on one artificially infected plot. In 1922 a cross was made between these two cottons. The progeny of this was selected and has been fixed since the year 1926. In 1930 it was given the name Jaywant (meaning "Victorious") and continues to justify its name. By means of a very efficient seed organisation it will in the current year (1931) have been spread over about two lakhs of acres. In yield, ginning percentage and staple it is entirely satisfactory, and for the time at least the wilt problem is no longer a source of worry, Jaywant being very wilt-resistant. There are other selections and crosses in Kumpta cotton made by the Breeder which must for the present be omitted and a few words said about breeding work in Dharwar-American cotton. As Dharwar was somewhat unsuitable for this type of cotton, a sub-station was opened in Gadag. In 1912 Mr. S. V. Shevade, L. Ag., then Cotton Supervisor, separated out green and white-seeded, yellow and white-flowered types, which were mass-selected and compared for yield. In 1913 Rao Saheb Kottur added two more types, *i.e.*, Hairy or Upland and Glabrous or New Orleans, and all six were tried. In 1914 three lines of Upland were pure and good and one of these gave rise to the cotton later named Gadag I, which is now the cotton of the Dharwar-American tract. In point of staple it is far superior to Dharwar-American, giving 0·84 inch as against 0·70 inch. In good years it is capable of spinning 38's and on the average will spin 32's. Its yield, on the average of six consecutive years, is given 466 lbs. seed cotton as against 390. The area under this cotton is generally in the neighbourhood of a lakh of acres.

## II. Khandesh Area.

The main bulk of the cotton grown in this area, which amounts to about 1,300,000 acres, is short-stapled and of somewhat inferior value in the world's markets. It has, however, a definite and not unimportant Indian demand. The cotton is early, high-yielding and high-ginning. Attempts to improve this cotton as to staple and spinning value, while at the same time retaining its high-ginning percentage, began as early as 1905, Dhulia being selected as the centre for such work. Introduction of new varieties, hybridisation and selection were the methods used. Of the introduced varieties Cambodia and Buri at first seemed successful but want of late rains seriously affected their outturn. On the whole the introduction of other varieties, whether Indian or foreign, was a failure. Attention was then concentrated on the local crop. This turned out to be an extraordinary mixture of five

varieties recognised as botanically distinct by Gammie. These were the following varieties of *G. neglectum*:—

*Rosea* * (generally called *Neglectum Roseum* or NR)
*Rosea cutchica*
*Vera*
*Vera malvensis*
*Vera kathiawarensis*.

NR cotton is narrow-lobed and white-flowered. Experiments made with these five varieties since 1909 have shown that NR is the best of them, being drought-resisting, early, with bolls that mature uniformly and open well. It gives a high outturn and having also a high-ginning percentage gives a large profit. The Department normally distributes seed for 30,000 acres NR annually. Since 1905 a series of crosses made originally during Mr. Fletcher's time between the rough and dense-fibred Comilla (*G. cernuum*) and the finer and more prolific Jari (*G. neglectum* var. *vera*) and Varadi (*G. neglectum* var. *rosea*) were tried. Most of these were unsuitable on account of late maturity. In 1908 such crosses were repeated and crosses were also made by Messrs. K. D. Kulkarni and M. V. Desai between Bani (*G. indicum*) and Comilla. These latter crosses were intended to combine the fine long staple of Bani with the high-ginning percentage of Comilla. The progeny of these crosses was continued, and in 1917 seven strains were supposed to be fixed but turned out still to be impure though promising. Work on these was continued by pure line selection and in the year 1926 one of these was found sufficiently uniform and useful to be given a name. It was called Dhulia I and tested rigidly against NR and other competing strains. It came well out of these trials and in the year 1929 was given the name "Banilla" under which it is now known and spread. In ginning percentage it gives 38 to 39 as against the 35 or 36 per cent. of unselected NR. It is capable of giving counts of from 12 to 20 as against NR's 8 to 10. Its yield is about the same as that of NR. Its average lint valuation per candy of 784 lbs. is Rs. 150 against Rs. 130 for NR. It has been an immediate success and the demand for the seed is enormous, the area now under the crop being upwards of 100,000 acres. It is hoped to increase its resistance to wilt in the near future. Recently, the Indian Central Cotton Committee has made a provision of Rs. 1,60,340 to be spread over five years for the purification and spread of this cotton in wilt-free zones.

*There has always been some confusion about the termination -*um* and -*a* in this connection, which it may be as well to clear up. The full name of NR cotton is *Gossypium neglectum*, varietas *rosea*. The adjective *neglectum* agrees with the neuter generic name *Gossypium* and the adjective *rosea* agrees with the feminine word *varietas* (Latin for *variety*).

## III. South Gujarat.

Surat was one of the earliest centres of agricultural experiment in the Bombay Presidency and the Farm is of long standing. Work on cotton began there in 1899 under Mr. Mollison. As already mentioned, some of Mr. Gammie's cottons were taken there and further selected by Mr. Fletcher and Mr. Main, the most famous being the one that finally resulted in 1027 ALF*. This is a hybrid the original parents of which (in the cross made by Mr. Gammie) were Goghari (a high-ginning short-stapled variety of *G. herbaceum*) and Kumpta (the *G. herbaceum* of the Southern Maratha Country). The final work on this progeny was done by the present Cotton Breeder of that area from the year 1917-18. Since 1919-20 three selections have been maintained pure by selfing and the one selection of these (the sub-type 1027 ALF), which is spread on a large scale, has occupied as much as 250,000 acres. The seed was first given out to cultivators on a large scale in the year 1919-20 when those interested in the growth and sale of Surat cotton came to the Department of Agriculture almost in despair and asked for something to be done to restore the good repute of that cotton. All available seed of 1027 ALF was then distributed, and as this was not enough, the seed of another selection called IA was also given out. It is rather an irony of fate that this latter variety should in recent years have seriously interfered with the spread, the purity and the usefulness of 1027 ALF, which was distributed as a still further purified strain from 1921-22. Variety IA has a higher ginning percentage and this has resulted in certain isolated communities (one in particular) resisting all attempt to cover the whole possible area with the one fine variety. Of the intrinsic value and beauty of 1027 ALF there is no doubt. As already stated it is the longest stapled Indian cotton (staple one inch and spins 26's to 34's according to the season). Its yield is also by no means low (the average of the last six years is 509 lbs. seed cotton per acre). The difficulties in connection with it show clearly that the difficulties of cotton improvement are by no means ended when the plant-breeder has evolved a good variety.

The Broach area presents other problems, including wilt, and the Cotton Breeder has been able to produce a good wilt-resistant variety called BD 8 (Broach Deshi 8) which is also being used in a series of crosses to combine high ginning percentage and long staple with the already good qualities of BD 8. This work is in progress.

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*The origin of this name was a sub-division of variety 1027 into 1027 and 1027 A and of the latter into 1027 A Long and Coarse and 1027 A Long and Fine (*i.e.*, ALF).

## IV. North Gujarat.

North Gujarat is the home of a cotton variety called Wagad which belongs to the species *G. herbaceum*. It has the peculiarity that its bolls open only a very little way. Harvesting of cotton is done by picking the complete bolls and the cotton is extracted in the houses of the people. The Cotton Breeder of this area has now in hand certain selections from the local cotton, some made by the Cotton Breeder, S. Gujarat, among which the varities Wagad 4 and Wagad 8 are prominent. They have been pure since 1919-20. Wagad 8 gives about 3 per cent. more ginning percentage than local and is superior in yield, while Wagad 4 is particularly superior in staple. Various crosses have been made between these Wagad varieties and 1027, with the object of getting a cotton with the Wagad type of boll opening and a better staple. The progeny of the crosses so made present a large range of variation and work is now in progress on the isolation from this mass of forms of types likely to be useful.

## V. Sind.

Experiments with exotic cottons in Sind date from 1846, when Egyptian seed was tried by Dr. Stocks at Shikarpur and Sea Island at Rohri by Major Golding. Both were unsuccessful. From 1852 to 1854 Sea Island and New Orleans cottons were again tried without success under an American planter, Mr. Prince. From 1868, for about 20 years, experiments on cotton introduction were carried on at farms opened near Hyderabad and Karachi, by Mr. Strachan, the cottons including both American and Indian varieties. This work must be called inconclusive.

With the opening of the Jamrao Canal and the establishment of the present Agricultural Department exotic cottons were once more the subject of experiment. Mr. Fletcher (already mentioned in this article) started experimental work at Dhoro Naro with the Egyptian cottons, Yannovitch, Abassi, Mitafiffi, and Ashmoni, and also some American cottons. The work was subsequently transferred to Mirpurkhas where the yields were not so good but on the strength of the one good year at Dhoro Naro, Egyptian cotton seed continued to be imported year after year and tried out on an area that at one time reached 6,000 acres. The water-supply, however, became precarious and the cultivation was abandoned but sufficient experience had been gained to show that the breeding of a strain suitable to the Sind conditions was essential.

American cottons were also the subject of experiment and by 1906 had been narrowed down to a few varieties. By 1909-10, Mr. G. Henderson, then Deputy Director of Agriculture in Sind, recorded his opinion that Upland American cotton

could be grown in any part of Sind. By 1912-13, Mr. Henderson decided to push on the American variety "Triumph", but the indifferent performance of the Jamrao Canal and the inadequate prices fetched by the cotton caused the attempt to be abandoned. Mr. Main then directed special attention to Punjab 4 F and other Punjab-Americans. Side by side with this work on Americans, selection was started on Sind Deshi cotton. The present Cotton Botanist (Mr. T̄hadani) then began his work. Sind cotton (like Khandesh cotton) was found to consist of several varieties of *G. neglectum.* The varieties found in Sind were *rosea, cutchica, vera* and *malvensis.* Studies were made of natural cross-fertilisation of cotton in Sind, and pure-line selection was begun. The *vera* and *malvensis* strains were gradually eliminated for poor ginning and poor yield respectively. Out of the *rosea* variety the type now known as 27 WN was evolved. This strain is capable of yielding up to 1,758 lbs. seed cotton per acre and averages about 1,000 lbs. It is early, gives about 5 per cent. more ginning than the *deshi,* has a bright colour and rough feel and is appreciated by the trade. Steps were also taken to isolate suitable strains from the Punjab-American cotton that had spread into Sind and of these the following have been isolated

4 F (strain 18)
285 F (strain 2)
285 F (strain 1)

Attention is at present concentrated on the first of these, which is being multiplied. The opening of the Sakrand Research Station was the signal for launching a new and comprehensive programme of work upon the whole range of cottons, Sea Island, Egyptians, Americans, and Deshi. As regards exotics the work takes the form of selecting strains suitable for post-Barrage conditions. Among the strains already selected can be found cotton varieties suitable for all purposes. These selected varieties can for convenience be divided into three classes, as follows :—

*Class I.*—This comprises two strains, *viz.*, Sea Island 2-4 and Boss III-16 (an Egyptian cotton). These possess a staple of 1¼ to 1½ in. and spin 60's to 80's.

*Class II.*—This comprises five strains, *viz.*, Ashmoni 37 (an Egyptian variety), Hartsville 111 and Acala 27 (both American), 285 F-21 and 289 F-1 (both Punjab-American). These possess a staple of 1 to 1⅛ in., and spin 40's to 50's.

*Class III.*—Comprises two strains, *viz.*, 4 F-98 and 285 F-2 possessing a staple of ⅞ths to 1 in. and spinning 34's to 40's. As regards yield the order of these classes is practically reversed. The finer cottons are more susceptible to fluctuations of season and soil. These cottons are now being tested all over Sind in rigidly controlled scientific trials. Crosses have been made of Punjab-American

cottons with Sea-Island, with Pima (Egyptian) and with the American cotton Meade. The progenies of these are under study and, in addition to direct plant-breeding work, information of value as to the inheritance of certain characters has been forthcoming.

### CONCLUSION.

It is hoped that this very short and incomplete sketch has been sufficient to give a bird's-eye view of the activities of a small band of geneticists working on one crop in a province of very diverse conditions. The success which they have achieved in a comparatively short time should both serve to justify the application of science to agriculture and also be a note of cheer to all their colleagues throughout India.

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# AGRICULTURAL CHARACTERISTICS OF INDIAN AND AMERICAN COTTONS IN THE KUMPTA-DHARWAR AREA.

BY

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## I.—Introduction.

Dharwar enjoys both monsoons, and the climatic conditions are, on the whole, favourable for growing a large number of cotton varieties, of Indian and American origin. The local cotton is Kumpta, a variety of *Gossypium herbaceum* but the New Orleans seed introduced by the East India Company about the year 1830 is still extensively cultivated under the name of Dharwar-American. On the experimental farm at Dharwar, Indian and American cottons have been tried for a number of years and the facilities thus afforded have enabled the writer to make observations on the agricultural peculiarities of these cottons.

## II.—Characters Studied.

The following characters which have a bearing on the successful cultivation of any cotton and are thus important to agriculturists, have been studied.

1. *Habit of growth.*—Indian cottons make slow progress in the early stage and the comparison between the two groups is then striking. But the American cottons stop growing much earlier, so that by the time the flowering commences the position is quite reversed. At the end of the growing period, Indian cottons attain a height of 5 to 6 feet and the Americans 3 to 4 feet. At Dharwar, monopodial branches are much suppressed owing to the late sowing. Indian cottons however produce a varying number of monopodia and can accordingly be divided into sympodial and monopodial types. American cottons produce few monopodia and are all of sympodial type. In addition to the basal monopodia, Indian cottons produce vegetative shoots from the axils of the leaves on the main stem. These axillary growths rarely produce any crop but they interfere with the productivity of the fruiting branches and are a disadvantage. American cottons do not produce axillary shoots at all. On the whole, Indian cottons are more vegetative than American.

2. *Flowering.*—Among Indian cottons the sympodial types are early and the monopodial ones are late. But many of the American cottons are earlier than the sympodial Indian cottons. They flower within sixty days after sowing. All early cottons however flower in October when heavy showers are expected. After these

showers there is a cessation in flowering which is more prolonged in the case of Indian cottons. American cottons are thus early to flower and early to recover from the effects of the October rains.

3. *Sowing time.*—In the Kumpta-Dharwar area the middle of August is considered to be the most suitable time for sowing cotton. Cottons then sown have sufficient time to finish the necessary vegetative growth and flower when there are no rains. But owing to the uncertainty of the *kharif* rains, the sowing is done actually from the middle of August to the middle of October. Indian cottons, including the local Kumpta, when sown later than the month of August, suffer in vegetative growth and flower late. For these reasons late sowing in the case of these cottons is detrimental to yield. In the case of American cottons, however, the effect is not so marked. These cottons can be sown in September without any adverse results. In some years sowing done as late as the middle of October has given normal yields. American cottons are therefore better suited for late sowing.

4. *Soil exhaustion, manure and rotation.*—Cotton and *jowar* (Sorghum) is the most common rotation in the Kumpta-Dharwar area. Where both Indian and American cottons are grown, the experience of the cultivators is that Indian cottons exhaust the soil more. This the cultivators know from the yields of the succeeding crop of *jowar* which are always heavier after American cottons. The latter therefore forms a better rotation for *jowar* which is the most important staple crop in the tract.

Indian types of cotton as grown at Dharwar do not respond to direct manuring. If at all the yield is increased, it often does not cover the cost of the manure. For this reason Kumpta cotton is always grown without any manure. American cottons however respond to manure and the growers do manure the Dharwar-American cotton in the tract.

Kumpta cotton is generally rotated. A two-year rotation of cotton and *jowar* is more common in the Kumpta-Dharwar tract. Cotton after cotton is seldom taken and the experience of those who have tried it is very much against it. All Indian cottons need rotation Apart from the reduction in yield which invariably follows, there is the danger from disease, especially wilt. In the case of American cottons rotation is desirable but we can dispense with it if necessary. In the Dharwar district many cultivators continuously grow Dharwar-American cotton without any rotation. They think that they can with proper manuring do so indefinitely.

5. *Resistance to drought.*- This point has not been studied very carefully. One might expect that American cottons with large leaves would suffer more from drought. But our experience is that these cottons do well in dry years. Among

Indian types there is a good deal of variation but the best drought-resistant cottons come from this group.

6. *Irrigation.*—All irrigated cottons give increased yield in the Kumpta-Dharwar area, and although the scope for this kind of cultivation is very limited, high prices for cotton now and then stimulate its cultivation at the expense of other corps in the canal and garden areas. If irrigation water is available in May, sowing of the *neglectum* types of cotton, especially the *G. neglectum* var. *rosea* yields best. If, however, the sowing has to be done in July or August, the *herbaceum* types are best. In both these conditions American cottons were tried and found unsuitable. Of the American cottons Cambodia and Gadag I, both of which are very hairy, are more suitable than others.

7. *Insect pests.*—Indian cottons are remarkably free from the attack of insects with the exception of the spotted boll worm (*Earias*) which is responsible for some shedding of young bolls and flowers. American cottons have also the boll-worm which is common, but in addition, are subject to the attacks of the following :—

1. Red mite. (*Tetranychus bioculatus*).
2. Jassids. *Emposæ Gossypii.*
3. Thrips. (*Thrips*).
4. Aphis. (*Aphis Gossypii*).

All these are very serious for American cottons. Jassids appear almost every year and are more severe on glabrous types. They concentrate their attack on the tender leaves and shoots and kill many young plants. The plants which thus succumb to their attack can be distinguished by the blackened shoots. In the case of older plants many of the affected leaves turn brown and shed. Red mites, like Jassids, attack the glabrous types more. All these are closely associated with the red and brown leaf-blights. These leaf-blights, it may be pointed out here, are the chief cause of the failure of American cottons in this part of the country. Aphides occasionally cause serious damage to the rain-fed American cottons, but their attack is almost always more severe on irrigated ones.

8. *Fungoid diseases.*—Cotton wilt caused by *Fusarium vasinfectum* is the only serious disease of the crop. It attacks the indigenous Kumpta cotton and causes serious damage in some localities. Dharwar-American cotton is entirely free from this trouble. Experiments conducted at Dharwar on heavily-infected soil show that all Indian cottons are susceptible to the attack of this fungus, while the American varieties are in general immune to it.

### III.—The future for American cottons in the Kumpta-Dharwar area.

American cottons are thus agriculturally better than Indian cottons in certain respects, but they were not introduced into this country for these characteristics.

They generally possess a longer staple and the history of American cottons is therefore intimately connected with the improvement of staple. With all the efforts, however, it has not been possible to grow longer-stapled varieties capable of spinning finer counts. We have Indian cottons which spin 30 to 40 counts and although the American cottons cultivated so far are not much better than these growths, the former have still some attraction for the growers as well as for the consumers.

Stapled Indian varieties generally require a longer growing period and they are mostly associated with low ginning percentage. They are cultivated only in those few tracts which are favourable for them. In all other tracts which have a shorter growing period short-stapled varieties predominate. In both these circumstances American cottons have an advantage over Indian varieties. In the tracts which already grow long-stapled Indian cottons the introduction of American varieties is likely to improve the ginning percentage without any loss in staple. Similarly the tracts which are growing short-stapled cottons may be made to produce long staple, without much loss in ginning outturn. The eastern part of the Dharwar district which is not suited for Kumpta cotton, grows almost entirely Gadag I [Kottur, 1922] a selection of Dharwar-American. The latter gins six per cent. more than the indigenous long-stapled Kumpta and possesses equally good staple.

The main problem of the Amerian cotton grower in this part of the country is how to eliminate or check leaf blights. Without this the cultivation is not attractive. In short, American cottons which resist the blights and in addition possess good long staple with finer spinning properties alone have a future.

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# MINERAL COMPOSITION OF THE FODDERS OF CENTRAL PROVINCES AND BERAR AND ITS BEARING ON ANIMAL NUTRITION

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For a long time studies on animal nutrition were directed towards finding out the energy values, starch values and albuminoid or nutritive ratios of food, and only recently importance is being attached to the mineral composition of the food or ration. It is now recognized that some of the diseases, functional disorders and in some cases malnutrition of the cattle are due, and can be traced, to the deficiencies of mineral salts in the ration.

An attempt has been made to study the mineral composition of the ration commonly fed to the cattle of the Province. Since grass, *Juar kadbi* and coarse fodders form the major portion of the feed of the cattle, mineral composition of these fodders collected from various parts of the Province has been ascertained.*

In Table I is given the mineral composition of the various important indigenous grasses of the Province, grown at the College Farm, Nagpur, in the area of the Second Economic Botanist, Central Provinces. In Table II is set out the mineral composition of the natural grasses and fodders grown in different parts of the Province.

TABLE I.

*Mineral composition of the indigenous grasses grown at the College Farm, Nagpur.*

(Percentages expressed on 100 parts of dry matter.)

| Description of grass | Silica-free ash | Ca O | $P_2O_5$ | $K_2O$ | Nitrogen |
|---|---|---|---|---|---|
| (1) *Ischaemum sulcatum* (*Paonia*) . . | 2·40 | 0·52 | 0·326 | 0·50 | 0·58 |
| (2) *Ischaemum laxum* (*Sheda*) . . | 3·56 | 0·589 | 0·223 | 0·507 | 0·43 |

* The samples were all collected when they had attained full maturity. Mineral composition of the fodders and grasses cut at different stages of maturity is being ascertained and the results will be set forth in a separate paper.

TABLE I—*contd.*

| Description of grass | Silica-free ash | Ca O | $P_2 O_5$ | $K_2 O$ | Nitrogen |
|---|---|---|---|---|---|
| (3) *Andropogon purpureosericeus* (*Sani baba Jara*). | 3·72 | 0·748 | 0·321 | 2·13 | 0·57 |
| (4) *Iseilema laxum* (*Mushyal*) . . | 2·22 | 0·790 | 0·215 | 0·875 | 0·464 |
| (5) *Andropogon anulatus* (*Lahan marvel*) | 2·93 | 0·583 | 0·244 | 1·40 | 0·539 |
| (6) *Andropogon caricosus* (*Mothi marvel*) . | 2·34 | 1·14 | 0·142 | 2·36 | 0·334 |
| (7) *Andropogon pumilus* (*Diwaratan*) . | 7·87 | 0·864 | 0·374 | 1·39 | 0·816 |
| (8) *Andropogon pertusus* (*Kel*) . . | 3·02 | 0·761 | 0·315 | 0·941 | 0·643 |
| (9) *Andropogon monti cola* (*Gada sela*) | 3·12 | 0·870 | 0·478 | 0·625 | 0·634 |
| (10) *Apluda varia* (*Ponia*) . . . | 4·10 | 0·585 | 0·549 | 1·16 | 0·675 |
| (11) *Andropogon contortus* (*spear grass*) . | 2·25 | 0·446 | 0·330 | 0·412 | 0·450 |
| (12) Grass mixture of the 2nd Economic Botanist. | 8·08 | 3·94 | 0·310 | 1·57 | 0·871 |

TABLE II.

*Mineral composition of the grasses and fodders collected from different parts of the Provinces.*

(Percentages expressed on 100 parts of dry matter.)

| Description of grass | Silica-free ash | Ca O | $P_2 O_5$ | $K_2 O$ | Cl | Nitrogen |
|---|---|---|---|---|---|---|
| (1) Grass from Tharsa Farm | 3·19 | 0·449 | 0·183 | 0·545 | 0·341 | 0·731 |
| (2) Grass from Khandwa Farm. | 1·69 | 0·505 | 0·0345 | 0·354 | 0·0149 | 0·287 |
| (3) Grass from Sindewahi Farm. | 1·66 | 0·465 | 0·0728 | 0·354 | 0·0128 | 0·395 |
| (4) Grass from Raipur Farm | 2·77 | 0·669 | 0·211 | 0·337 | 0·263 | 0·549 |
| (5) Grass from Buldana Farm. | 1·19 | 0·389 | 0·0456 | 0·544 | 0·112 | 0·305 |
| (6) Grass from Borgaon Farm. | 1·73 | 0·565 | 0·0615 | 0·439 | 0·151 | 0·292 |

TABLE II—*contd.*

| Description of grass | Silica-free ash | Ca O | $P_2O_5$ | $K_2O$ | Cl | Nitrogen |
|---|---|---|---|---|---|---|
| (7) Grass from Seoni Farm | 3·60 | 0·688 | 0·243 | 0·965 | 0·214 | 0·574 |
| (8) Grass from Powarkheda Farm. | 3·69 | 0·732 | 0·178 | 0·872 | 0·549 | 0·466 |
| (9) Grass from Betul Farm | 3·36 | 0·580 | 6·276 | 0·934 | 0·272 | 0·565 |
| (10) Grass from Adhartal Farm. | 2·04 | 0·488 | 0·115 | 0·173 | 0·173 | 0·705 |
| (11) Grass from Tellankheri Farm, Nagpur. | 3·93 | 0·537 | 0·359 | 2·00 | 0·0714 | 0·558 |
| (12) Hay from Tellankheri Farm, Nagpur. | 1·98 | 0·675 | 0·062 | 0·693 | 0·040 | 0·416 |
| (13) Guinea Grass (Nagpur Farm). | 8·67 | 1·81 | 0·586 | 1·81 | .. | 1·32 |
| (14) *Glycine Hispida* (Soy-bean), Nagpur Farm. | 8·20 | 2·19 | 0·376 | 2·93 | 0·0540 | 2·65 |
| (15) *Dolichus Biflora* (*Kulthi*) (Nagpur). | 9·47 | 2·95 | 0·362 | 1·960 | 0·0040 | 2·52 |
| (16) *Cyamopsis* (*guar*) . . | 10·04 | 5·42 | 0·423 | 3·94 | 0·215 | 3·07 |
| (17) Berseem from Nagpur Farm. | 13·70 | 6·88 | 0·765 | 4·20 | 0·7956 | 3·02 |
| (18) *Kadbi* from Borgaon Farm. | 5·60 | 1·00 | 0·122 | 3·38 | 0·828 | 0·328 |
| (19) Paddy straw from Raipur. | 5·90 | 0·933 | 0·385 | 3·22 | 0·488 | 0·448 |
| (20) Wheat straw from Jubbulpore. | 3·93 | 0·717 | 0·150 | 0·778 | 0·238 | 0·380 |
| (21) Good cultivated pasture* (England). | 6·97 | 1·10 | 0·765 | 2·97 | 0·90 | 2·93 |
| (22) Poor Pasture not eaten* (England). | 3·13 | 0·30 | 0·37 | 1·61 | 0·33 | 1·82 |

*Taken from 'Minerals in Pastures' by J. B. Orr.

It will be seen from an examination of the figures in Tables I and II that C. P. grasses are very poor in phosphoric acid and calcium contents and generally resemble the sample of "Poor pasture not eaten in England". The grass produced from the seed mixture [Mahta and Dave, 1930] evolved and advocated by the Second

Economic Botanist, C. P., resembles the good pasture of England in mineral composition excepting that it is still deficient in phosphoric acid. The grass mixture of the Second Economic Botanist, C. P., which contains a high nitrogen and calcium content, is recommended to be tried on all farms wherever possible.

In Table III is given the mineral composition of the grasses grown in different typical soils of the Provinces.

TABLE III-A.

*Mineral composition of grasses grown on heavy soil.*

(Expressed per 100 parts dry matter.)

| Description of grass | Silica-free ash | Ca O | $P_2O_5$ | $K_2O$ | Cl | Nitrogen |
|---|---|---|---|---|---|---|
| Powarkheda Farm Maryar soil (8). | 3·69 | 0·732 | 0·178 | 0·872 | 0·549 | 0·466 |
| Tharsa Farm Morand soil (1) . | 3·19 | 0·449 | 0·183 | 0·545 | 0·341 | 0·731 |
| Raipur Farm Kanhar soil (4) . | 2·77 | 0·669 | 0·211 | 0·337 | 0·263 | 0·549 |

TABLE III-B.

*Mineral Composition of grasses grown on light soil.*

(Expressed per 100 parts dry matter.)

| Description of grass | Silica-free ash | Ca O | $P_2O_5$ | $K_2O$ | Cl | Nitrogen |
|---|---|---|---|---|---|---|
| Sindewahi Farm Wardi soil (3) | 1·66 | 0·465 | 0·0728 | 0·354 | 0·128 | 0·395 |
| Grass from Khandwa Farm Light soil (2). | 1·69 | 0·505 | 0·0345 | 0·354 | 0·149 | 0 287 |
| Grass from Buldana Farm Light soil (5). | 1·19 | 0·389 | 0·0456 | 0·544 | 0·112 | 0·305 |

From an examination of the figures in Table III it will be seen that where the soil is heavy and contains a high clay content and consequently is more rich in mineral substances than a light soil, the grass grown on such a heavy soil is richer in mineral composition than that grown on a lighter soil. As fertility of the soil affects the composition of the grass grown on it, experiments have been laid out at Adhartal and Nagpur Farms to improve the mineral composition

of the grasses by suitable manuring. The results of these experiments will be published later.

In the eastern parts of the Province, *viz.*, Chhattisgarh Division, paddy straw and the grass growing there form the maintenance ration of the cattle. In the western and the middle parts of the Province, *viz.*, Berar and Nagpur Divisions, green *Juar*, *kadbi*, and the grass growing in the parts comprise the maintenance ration, whereas in the northern parts of the Province, *viz.*, Jubbulpore, wheat straw and the grass make up the maintenance ration. Sometimes the cattle may get a little cotton seed or *til* cake. The mineral composition of the fodders forming the maintenance ration of the cattle in the three parts is given below (Table IV).

TABLE IV-A.

*Mineral composition of the fodder and concentrate (Eastern part of the Province).*

| Name of the sample | Ca O | $P_2O_5$ | $K_2O$ |
|---|---|---|---|
| (1) Grass, Raipur . . . . . . . . | 0·669 | 0·211 | 0·337 |
| (2) Paddy straw . . . . . . . . | 0·933 | 0·385 | 3·22 |
| (3) *Tur Chuni* . . . . . . . . | 0·371 | 0·568 | 1·57 |
| (4) Cake (*Til*) . . . . . . . . | 2·42 | 2·03 | 1·30 |
| (5) Rice Konda . . . . . . . . | 1·06 | 7·49 | 0·913 |

TABLE IV-B.

*Berar and Nagpur Division.*

| Name of the sample | Ca O | $P_2O_5$ | $K_2O$ |
|---|---|---|---|
| (1) Grass Nagpur . . . . . . . | 0·565 | 0·0615 | 0·439 |
| (2) *Juar* . . . . . . . . . | 1·00 | 0·122 | 3·38 |
| (3) Cotton seed . . . . . . . . | 0·406 | 1·20 | 0·943 |

TABLE IV-C.

*Jubbulpore Division.*

| Name of the sample | Ca O | $P_2O_5$ | $K_2O$ |
|---|---|---|---|
| Grass from Adhartal . . . . . . . | 0·488 | 0·115 | 0·173 |
| Wheat straw . . . . . . . . | 0·717 | 0·150 | 0·778 |
| Cake (*Til*) . . . . . . . . . | 2·12 | 2·03 | 1·30 |
| Lakhori . . . . . . . . . | 0·378 | 0·83 | 1·05 |

If the cattle do not get some concentrate daily, the mineral requirements of the cattle are solely met from the bulk fodder. It is only occasionally the ordinary cattle get concentrates. All the fodders are invariably deficient in phosphoric acid. The lime deficiency may not be so pronounced as *Juar, kadbi,* paddy straw, and wheat straw contain a good proportion of lime. The addition of an oil-cake in the ration may make up a little towards the phosphoric acid deficiency. The mineral requirements of a growing calf and a milch cow are greater than those of the ordinary cattle.

Although mineral requirements of the cattle in India have not been ascertained, preliminary experiments conducted on Adhartal Farm, Jubbulpore, on feeding with bonemeal tend to show that the cattle are immensely benefited.

The problem of supplying sufficient phosphoric acid to the cattle will have to be tackled.

## SUMMARY AND RECOMMENDATIONS.

(1) Mineral composition of the grasses and fodders growing in different parts of the Provinces used as cattle-food is given.

(2) The grasses grown on heavy black soils are richer in mineral content than those grown on light soils.

(3) C. P. grasses are very poor in phosphoric acid and calcium contents compared with the good pasture of England.

(4) The lime deficiency may not be so pronounced as phosphate deficiency, for *juar, kadbi,* paddy straw and wheat straw which form a good part of the ration contain high proportion of lime.

(5) The problem of supplying sufficient phosphate to the cattle must be solved. Experiments on the economic feeding of phosphate to the cattle are now proposed to be carried out at different farms.

(6) The addition of an oil-cake may make up a little towards the phosphate deficiency, and the lime deficiency if any can be made up by addition of leguminous fodders in the ration.

(7) The poor stunted growth of the cattle in Chhattisgarh may be due to the phosphate deficiency in the ration.

(8) Our grasses are very deficient in nitrogen content.

(9) Growing and feeding of leguminous fodders such as berseem, *guar*, soy-bean, *kulthi*, *lakhori* where possible should be encouraged.

(10) In the rice tract, the rice polishings (*konda*) which is rich in phosphoric acid should not be wasted but utilised in feeding to the cattle.

(11) In the wheat tract *bhusa* of the leguminous crops should form a part of the ration to the cattle.

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# A NOTE ON SUGAR RESEARCH IN INDIA.

BY

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## Part I.

### THE EXISTING ORGANIZATION AND SCOPE OF SUGARCANE RESEARCH AND EXPERIMENTAL WORK IN INDIA.

The following note is divided into three sections dealing with (*a*) breeding of improved varieties and associated problems, (*b*) fungus and virus deseases, (*c*) insect pests. The following officers of the Imperial Institute of Agricultural Research. Pusa, are responsible for the preparation :—

*Section* (*a*).—Rao Bahadur T. S. Venkatraman, Government Sugarcane Expert ;

*Section* (*b*).—Dr. W. McRae, Imperial Mycologist ;

*Section* (*c*).—Mr. T. Bainbrigge Fletcher, Imperial Entomologist.

*Section* (*a*).—*Breeding of improved varieties and associated problems.*

I. *Origin.*—The Coimbatore Station was started in response to a demand from the Imperial Legislature of the pre-Reform days and the Press. It was urged that the steadily increasing imports of white sugar into India was having a very depressing effect on the indigenous raw sugar industry. It was feared that, if the increase continued, India might lose yet another crop in the sugarcane which would have a very disastrous effect on the agricultural economics of the land. The All-India Board of Agriculture in 1911 recommended such a station, and it came into being in 1912.

II. *Object.*—Though India has within her confines an area under sugarcane more than that of any other single country of the world, she has to import every year large quantities of white sugar (worth between fifteen and twenty crores of rupees) even to meet her domestic needs. This is because of the relatively low acre production of cane in India and of defects and wastage in methods of manufacture. The reason for the low acre yields, though perhaps partly agricultural, was found traceable in a large measure to the poor class of canes grown over the bulk of

the Indian area. The Station was started to breed improved canes for every part of India.

III. *Scope of research and experimental work.*—The breeding of improved canes for every part of India—with its wide variation of soil and climatic conditions—was sought to be achieved by growing the cane from seed instead of from cuttings as is ordinarily done by the cultivators. This method had proved its utility for the purpose in the other cane countries of the world. When the Station started working, however, it was found that the experience of the other countries was of but limited use to India, as the problems were rather different and in certain respects complicated and unique. For one thing the breeding technique had to be greatly improved. Secondly, the indigenous canes had to be exhaustively studied to obtain ideas about the direction in which the improvements are needed. The cane plant had also to be studied as an organic whole and in all its bearings to soil and climatic environments.

The research and experimental work in progress at the Station includes :—

(1) Studies on times of flowering and floral fertilities and experiments to control and influence both.

(2) Improvements in breeding and nursery technique for raising in large numbers the type of seedling desired. These involve studies in methods of pollination, germination and preservation of sugarcane pollen, stigma receptivity, and preservation of seeds in viable condition.

(3) Raising experimental batches of seedlings from each parent for securing data on the type of seedlings produced and the inheritance of characters. This has resulted in a 'black' list of parents not to be used in crossing. Constant investigations are in progress to discover the particular parent to employ for securing in the resultant hybrids such characters as are desired.

(4) Descriptions of canes for purposes of identification and studies in external morphology for classification purposes.

(5) Studies on sugarcane germination, the right kind of material to plant sporting in canes, and mode of branching.

(6) Studies on root-systems of different varieties, including plan and rapidity of development, anatomy, periodicity and susceptibility or resistance to adverse soil conditions. Breeding experiments with a view to influence and alter the type and rapidity of root development.

(7) The chemistry of the sugarcane plant, including estimation of juice quality, study of factors affecting this quality, mode of ripening and effect of germination on the composition of the planted cuttings.

(8) Study of the internal and external morphology of canes for ascertaining possible factors rendering them resistant or susceptible to various pests and diseases and to animal attacks.

(9) Study of the wild sugarcanes with special reference to their hardiness, root-systems and disease resistance to explore the possibility of their use as parents in cane-breeding. The comparative health of the crops in the area devoted to the breeding of medium types is considered to be largely due to the use as parents of wild and hardy canes.

(10) Experimental testing of the new productions alongside of the standard canes for their botanical and agricultural characters and juice quality.

(11) Besides the above, there are in progress sundry investigations on methods of labelling, methods of transporting live cane material. propping of canes and attempts at improvement of tools used in the various agricultural operations.

IV. *Organisation.* --The organization for carrying on the above research and investigational work consists of :—(1) A farm consisting of 90 acres. Out of this 29 acres is ear-marked for work in connection with the breeding of the thick type of canes. (2) Two Class I Officers one of them devoting his time entirely to the breeding of the thick type of canes –and one Class II Officer. (3) Seven botany and agricultural assistants with a suitable subordinate staff under them.

The bulk of the Indian area is situated in the sub-tropics and about two thousand miles away from Coimbatore. To obtain data regarding the behaviour of the new productions in the provinces and suitably adjusting the breeding programme at Coimbatore on such data, the staff tour in the provinces and try and maintain personal touch with the local officers of each province. A sub-station in North India has been considered a desideratum for some time ; and during the current year such a station on a temporary footing for five years has been started with the help of funds placed at the disposal of the Imperial Department of Agriculture by the newly constituted Imperial Council of Agricultural Research.

V. *Results obtained.*—The area under the improved canes bred at Coimbatore and distributed in the provinces by the provincial departments of agriculture is rapidly approaching 20 per cent. of the total area and is bound to rapidly increase in the future. The increased profit to the growers from the cultivation of the Coimbatore canes in place of the old kinds is estimated at about four hundred lakhs of rupees. The expenditure on the station is about three quarters of a lakh.

*Section (b).—Fungus and virus disease.*

**The organization for the investigation of sugarcane diseases in British India consists of a Mycologist with appropriate staff in Pusa ; Lyallpur, Punjab ; Cawn-**

pore, U. P.; Nagpur, C. P.; Poona, Bombay; Coimbatore, Madras; and Mandalay, Burma, and in Indian States in Bangalore, Mysore State; and Trivandrum, Travancore State. These laboratories deal with diseases of agricultural crops within the areas they serve. The following is an indication of the work being done with regard to diseases of sugarcane :—

*Pusa.*—The following diseases described in Butler's "Fungi and Disease in Plants" have been investigated in Pusa :—Smut (*Ustilago scitaminea*), rust (*Puccinia kuehnil*), ring spot (*Leptosphaeria sacchari*), black rot [*Sphaeronema adiposum* Butl., *Ceratostomella adiposum* (Butl.) Sartoris], dry rot (*Thyridaria tarda*), collar rot (*Hendersonina sacchari*), red rot (*Colletotrichum falcatum*), wilt (*Cephalosporium sachari*), brown leaf spot (*Cercospora longipes*), helminthosporium (*Helminthosporium sacchari*) banded sclerotial disease and sooty mould. Root-rot, top-rot, *Sclerospora sacchari* and mosaic disease are under investigation. Mosaic disease was discovered in Pusa in 1921, was suspected in 1924 and diagnosed again in 1925. Since then the Pusa staff has discovered it in every province in India, except the Central Provinces and Burma where it was found by the local mycologist after a search induced by the information received from Pusa of its widespread existence. The amount of mosaic in 1925 in Pusa varied on the different varieties up to 60 per cent., while by 1931 it had been brought down to ·005 per cent. by continuous roguing.

Experiments have shown that mosaic disease has spread very slowly in Pusa during the last three years in contradistinction to the results in Coimbatore where it spreads extremely rapidly. The vector of spread has not clearly demonstrated in India yet.

A careful experiment has demonstrated the exact loss in tonnage and in quality of juice due to mosaic disease in the season 1930-31. The loss in tonnage in Co. 213 was 4·6 per cent. and in Co. 205 was 8·6 per cent. In Co. 213, the quality was reduced to a small extent, while in Co. 205 there was little, if any, reduction.

Red-rot which once was a serious disease on Pusa Farm has been eradicated by careful selection at planting. During the last four years the crop has been completely free from this disease.

The Imperial Council of Agricultural Research has made a grant of Rs. 49,210 for the further investigation of mosaic and other disease of cane and this year additional staff will be recruited and a new laboratory built in Pusa.

*Punjab.*—A committee for the study of mosaic was formed in 1928 with the Associate Professor of Botany as convener. The lines of work are (*a*) a study of the cause of mosaic disease and its effects on the sugarcane crop and (*b*) measures of control. For this work a quarter acre plot of Co. 223 on the Lyallpur Farm was

set aside. The disease became evident about the end of May and remained distinguishable till the end of December, *i.e.*, as long as the leaves of the heart of the plant remained green. It is reported that stems of mosaic infected plants when grown by themselves become stunted in growth; the length of the internodes in the upper half of the cane being reduced to about half the normal size.

Cane is being rogued on all the farms in which it is grown.

*Central Provinces.*—Streak disease was found on four varieties of cane only on those farms where Java 213 was grown but is not considered of much importance and mosaic disease has apparently but little ill effect. An investigation of Striga (Agya) is being carried on, and it has been found that an application of a 3 per cent. solution of copper sulphate destroyed the parasite without damaging the cane.

*Madras.*—A survey of mosaic disease in the varieties of thick and thin canes in the Presidency has been made and it has been found in all the cane-growing areas. Experiments to test the rate of spread and the relative susceptibility of varieties have been in progress for three years. In Coimbatore the spread in the field is very rapid. In thick canes stunting is sometimes apparent and the characteristic markings are seen on the stem. Here it may be recalled that stunting has been noticed in the Punjab also but nowhere else.

*Burma.*—The incidence of mosaic disease in the various agricultural stations has been determined. An investigation of the amount of spread and of the relative susceptibility of the varieties grown in Burma is being made and it has been stated that mosaic reduces the tonnage and the sucrose content.

*Section* (c).—*Insect Pests.*

As regards organization of work in India on cane pests, there is no all-India organization. What work is being done is scattered and unco-ordinated and, so far as I know, there is no inter-provincial supply of information on this subject.

So far as Pusa is concerned, we have studied cane pests, and especially borers, for the last fifteen years or so, and have acquired a fair knowledge of the occurrence, life-histories and identities of the various insects which attack sugarcane. The information obtained was published in the Report of the Second, Third and Fourth Entomological meetings (and separately in Bulletins) and in the Annual Reports of the Imperial Entomologist. At present experiments on control of *Scirpophaga* are being done.

In Madras some investigation of cane-borers has been made, mostly at Coimbatore and in the Godavari District, but, so far as is known, no continuous work

has been done or any results published. In Mysore Dr. Kunhi Kannan investigated the local cane-borers about 1918-22 and wrote a short note in the *Proc. Fifth Entom. Meeting*, but no more recent work is known. In Burma some preliminary investigation of cane-borers was made in 1921-22 and a short note published also in *Proc. Fifth Entom. Meeting*, but no more recent results are available. Sporadic investigation of borers has also been made in the Punjab, whence a new species of borer was sent to Pusa, but no general or recent results are available.

As regards scope of sugarcane pests' research, attention has previously been drawn to the large losses caused by borers, which may be placed at Rs. 30,00,00,000 annually at a conservative estimate. With the introduction of the more succulent Coimbatore canes into Northern India and the extension of large areas of cane in new districts, such as North Bihar, such damage is likely to increase very considerably in the near future.

As regards means for the mitigation of such damage, a special expansion of staff is required to take up this work on a larger scale than is possible at present.

## Part II.

### THE ECONOMIC POSITION OF THE INDIAN SUGAR INDUSTRY WITH SPECIAL REFERENCE TO COST OF PRODUCTION.

India is believed to be the original home of sugarcane and the existence of a sugar manufacturing industry in India can be traced back to at least twenty-five centuries. At present India is the second largest sugar-producing country in the world although the bulk of its output is of an inferior kind. The area under cane in India is about 3 million acres, which is approximately a quarter of the world's sugarcane acreage. Of this area, 75 per cent. lies in the three provinces -- Bihar, the United Provinces and the Punjab. Although these provinces lie in the subtropical regions, the high temperature and humidity during the monsoon months from June to September are extremely favourable to the growth of cane and the succeeding dry months hasten its ripening. The natural advantages conducive to an abundant supply of raw material are therefore obvious.

In respect of supply of labour also India stands in a favourable position as compared with other sugar-producing countries. It is necessary that sugar factories should be located within easy reach of their cane supplies, as it is proved that the sucrose content of cane decreases if considerable time elapses between cutting and crushing. Thus the majority of the sugar factories are situated in rural areas and draw their labour supplies from the surrounding villages. The season of sugar manufacture extends roughly from the time when the *kharif* crop is reaped until

the *rabi* is harvested, the months in which agricultural employment is generally small. For this reason little difficulty is experienced in obtaining an adequate supply of labour. The following table shows in a comparative form the rough average figures for wages paid to unskilled labour in different sugar-producing countries :—

| Countries | Wages Rs. | a | p. | |
|---|---|---|---|---|
| India | 0 | 8 | 0 | |
| Java | 0 | 8 | 10 | |
| Philippines | 1 | 0 | 0 | |
| Natal | 1 | 12 | 10 | |
| Mauritius | 2 | 5 | 4 | |
| Cuba | 3 | 5 | 4 | |
| Hawaii | 4 | 0 | 0 | |
| Queensland | 11 | 5 | 4 | 2*s*. per hour for 8 hours 40 minutes work per day. |

India is in a still stronger position in having a large home market for sugar. At present India imports about one million tons of sugar annually, about 100,000 tons is manufactured in India in refineries or central factories, while a varying amount estimated at 200,000 to 250,000 tons is manufactured by *Khandsaris*. In addition to this some 2½ million tons of *gur* are consumed each year. The total consumption of *gur* and sugar may be valued at not far short of Rs. 60 crores, annually. Java, Cuba, the West Indies, Mauritius and Hawaii, the most important of the cane sugar producing countries, have practically no home market, the total consumption amounting to 630,000 tons against a production of about 8,800,000 tons annually. It is, therefore, obvious that in this respect India enjoys a decided advantage.

The *per capita* consumption of sugar (excluding *gur*) in India is increasing from year to year, while that of *gur* has been decreasing. The Indian sugar industry has therefore a two-fold scope for expansion in the home market, *viz.* :—

(*a*) by displacing the imported white sugar,

and

(*b*) by displacing the indigenous *gur*.

Passage may now be made to the cost of sugar production in India. Factories look for their cane supplies to the small holder as about 99 per cent. of the cane produced in India is grown by him, and in order to attract and obtain sufficient supplies, the price offered should be adequate enough to persuade him to depart from his old practice of turning the crop into *gur*.

The following statement gives figures for two typical Indian factories employing the sulphitation and carbonation processes, crushing 400 tons cane per day of 22 hours, with a recovery of 9·2 and 8·7 per cent. cane respectively. The average prices of cane have been taken at Re. 0-6-11 and Re. 0-6-10 respectively per maund.

| Particulars | Cost of production per md. of sugar | |
|---|---|---|
| | Factory A Sulphitation | Factory B Carbonation |
| | Rs. | Rs. |
| 1. Cost of cane | 4·77 | 4·95 |
| 2. Fuel | 0·353 | 0·34 |
| 3. Lime stone, coke, sulphur and lime | 0·11 | 0·265 |
| 4. Lubricants | 0·08 | 0·19 |
| 5. Filter cloth | 0·023 | 0·136 |
| 6. Gunny bags | 0·17 | 0·19 |
| 7. Sundry mill stores | 0·06 | 0·07 |
| 8. Salaries and wages | 0·823 | 0·88 |
| 9. Managing Agent's charges | 0·30 | 0·35 |
| 10. Depreciation of machinery and buildings | 0·65 | 0·78 |
| 11. Maintenance of machinery and buildings | 0·209 | 0·097 |
| 12. Interest and Insurance | 0·188 | 0·067 |
| 13. Commission and Brokerage | 0·019 | 0·025 |
| 14. Miscellaneous charges | 0·106 | 0·142 |
| Total | 7·861 | 8·482 |
| *Deduct* molasses at Re. 1-6-0 at 3·6 and 3·2 per cent. on cane | 0·635 | 0·506 |
| *Net* cost of sugar per maund (including packing) ex-factory | 7·226 | 7·976 |
| Average | Rs. 7-8-11 per maund. | |

The price of cane is generally reckoned at Re. 0-6-6 per maund delivered at factory, which corresponds to Re. 0-5-0 to Re. 0-5-6 actually received by the grower. The return to the cultivator under present conditions is so small that it does not offer him any inducement for adoption of improved methods of cultivation. An enhancement of Re. 0-1-6 per maund is necessary, bringing up the price of cane paid by the factories from Re. 0-6-6 to Re. 0-8-0 per maund.

According to the report of the Indian Tariff Board on the Sugar Industry (1931), the figures for the costs of a typical Indian sugar factory employing the

sulphitation process, crushing 13 lakhs maunds of cane annually with a recovery of sugar 9 per cent., cane are given below :—

| | Per maund of sugar Rs. a. p. |
|---|---|
| 1. Cane at 8 annas a maund | 5 8 10 |
| 2. Other raw material | 0 2 0 |
| 3. Labour | 0 8 0 |
| 4. Power and fuel | 0 1 3 |
| 5. Supervision, office charges and establishment | 0 11 3 |
| 6. Current repairs | 0 7 0 |
| 7. Packing | 0 2 9 |
| 8. Miscellaneous | 0 10 0 |
| Total | 8 3 1 |
| *Deduct* molasses at Re. 1-8 at 4 per cent. on cane (52,000 mds.) | 0 10 8 |
| Net cost | 7 8 5 |

It is stated in the Report that all charges have been estimated on a comparison of various factories, allowance being made for exceptional circumstances. Whereas, as in the case of repairs and renewals considerable differences occur from year to year, average have been taken over a series of years.

The fair selling price of white sugar made at a similar factory is estimated in the Report as follows :—

| | Per maund of sugar Rs. a. p. |
|---|---|
| Cost of production | 7 8 5 |
| Overhead charges and profits @ 10 per cent. | 1 13 4 |
| Grand Total | 9 5 9 |

The following table showing published figures for costs of production in different countries is given for comparison.

| | Cost of production Rs. per md. |
|---|---|
| (1) Java | under 3·92 |
| (2) Cuba | 4·05 |
| (3) Fiji | 5·92 |
| (4) British West Indies | 5·96 |
| (5) Hawaii | 6·53 |
| (6) *India* | 7·56 |
| (7) South Africa | 7·58 |
| (8) Germany | 7·65 |
| (9) Formosa (High grade) | 8·46 |
| (10) U. S. Beet | 9·00 |
| (11) Australia | 11·09 |
| (12) Argentina | 11·70 |

In spite of favourable natural conditions the industry has to be helped by a high tariff on imports. This is so primarily owing to increased outside competition due to over-production. The efforts made by the industry to effect improvements have been successful to a large extent. By more efficient control of manufacturing operations and by more extended cultivation of improved canes the average recovery of white sugar factories has increased from 6·85 per cent. in 1919 to over 9·00 per cent. in 1929-30, the highest figure attained by any one factory being 10·43 per cent. The number of modern factories manufacturing sugar direct from cane has increased from 18 in 1919 to 30 in 1929-30, while 14 refineries make sugar from *gur*.

India in less able than other countries to weather the outside competition as the industry, particulary on its agricultural side, is passing through a period of reconstruction. The improved varieties of sugarcane which were introduced in recent years are being planted more widely every year. It is estimated that in 1930-31 over 815,000 acres (that is over 25 per cent. of the total sugar cane area in India) was cultivated with these canes.

These facts show what progress India has made and what position she now holds. The average recovery of sugar which, as stated above, is now over 9 per cent. on the weight of cane will, it is hoped, steadily increase. With improved varieties of cane, yielding crops of 30 tons and more per acre, the outturn of sugar per acre will amount to between $2\frac{3}{4}$ and 3 tons, which is higher than that of most other countries excepting Java. Steady progress in both the manufacturing and agricultural sides together with the recent increase in duty should result in materially bettering the economic position of the Indian sugar industry.

# SELECTED ARTICLES

## FIELD EXPERIMENTS.

BY

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(Reprinted from the *Journal of the Ministry of Agriculture*, Vol. XXXVIII, No. 3, June, 1931.)

In continuation of the series of conferences that have been held at Rothamsted during recent years, an interesting meeting took place on May 7, when the subject for discussion was the Technique of Field Experiments. Previous conferences have been rather in the hands of farmer visitors in the sense that most of the papers were contributed by them, but the scientific and technical workers had the stage to themselves on this occasion. The gathering consisted largely of agricultural, educational and advisory officers, several being Imperial Agricultural Officers on leave in this country. Sir Daniel Hall, whose early work at Rothamsted in connexion with the experimental errors of field trials had opened up this important and fruitful field of investigation, was in the Chair.

Using as his illustration the yield data from the classical uniformity trial carried out by Marcer and Hall at Rothamsted in 1910, Dr. R. A. Fisher gave an exposition of the principles underlying field trials. The major source of error was unquestionably soil variation, working errors in the field being with ordinary care relatively unimportant. The urgent need in field experimentation was the reduction of error and its valid estimation. In discussing results we must be able to pick out those that could not reasonably be ascribed to chance causes. To achieve this it was necessary to replicate the treatments and assign them to the experimental area at random. A further principle was the division of the experimental area into "blocks" each one of which contained a single representative of each of the treatments, the actual position of the treatments within their block being random. While retaining the random principle this enabled gross fertility differences between blocks to be eliminated on calculating the results, with consequent reduction of error.

Prof. R. G. Stapledon followed with an account of the methods used in grassland studies at Aberystwyth. The chief point of interest which called for the development of a special technique, was the effect of the grazing animal on the sward. The most promising method so far developed was the use of tethered sheep. This enabled grazing of any required degree of intensity to be arranged, and also permitted of the high degree of replication necessary in such work. Replication, however, brought its own difficulties, for the amount of botanical analysis required to ascertain the changes in a large number of samples was enormous. The difficulty had been met by estimating the botanical composition of the herbage in place of the usual laborious analysis. Prof. Stapledon claimed that the results obtained in this way by a practised observer checked up remarkably well with the actual figures, and the much larger number of samples which it was possible to deal with justified this plan. The lawnmower, now frequently used in herbage experiments, produced an effect on the turf completely different from that of the grazing animal.

The technique of variety trails as carried out by the National Institute of Agricultural Botany was then described by Mr. S. F. Armstrong, and the practical details in his paper could not but be of great value to those taking up this class of work.

Manurial trials were dealt with from two points of view. Mr. A. H. Lewis of Imperial Chemical Industries, Ltd., in his paper on Multiple Schemes of Field Experiments, gave a very interesting account of the methods employed in carrying out, at a large number of centres throughout the British Isles, simple manurial trials on a uniform system. Three-by-three Latin Squares were used, and these, although of only slight precision taken singly, could yield valuable general results when statistically combined. A small travelling thresher mounted on a lorry had been very successful in dealing with cereal plots—always a difficult problem on the commercial farm. Some interesting results of work of this kind carried out on maize by the firms' representatives in Portugal were also communicated.

Another aspect of the mode of experimentation on commercial farms scattered over a wide area was presented by Mr. H. V. Garner, of Rothamsted, who described the methods used in repeating the rather complex experiments of the Research Station under ordinary farming conditions.

The special difficulties inherent in experiments on fruit and horticultural crops were set out by Mr. T. N. Hoblyn, of East Malling, and the methods employed to meet them were outlined. The long life of the crop plants, and the extreme variability of the material, made a series of individual records necessary in the case of fruit trees. The weight of crop produced was not the only consideration; the

amount of blossom was a further index of productivity. It was also necessary to record one or more of the various measures of "vigour" which were most suitable under the circumstances. To collect and handle these records and observations expeditiously, ingenious labour-saving devices have been developed, and some of these were described. The horticultural experimenter has special problems which do not trouble those dealing with farm crops; for example, when series of different trees are included in the same experiment it is difficult to decide whether a uniform or individual system of spraying or pruning should be adopted. On the whole a uniform system was preferable.

Mr. D. J. Watson, of Rothamsted, dealt with the principles and practice of sampling farm crops for estimation of yield. A satisfactory technique had been worked out for cereals that involved only a slight loss of precision. There were, however, gains in other directions, and in particular experimentation with cereals became possible on farms where the individual threshing of small plots was not practicable.

In the discussion which followed, several speakers pointed out that much had been done to improve agricultural practice by the use of comparatively crude methods of experimentation. This is true in new countries, where a manurial treatment or variety may produce striking effects, and straightforward methods have their uses to demonstrate large differences to farmers. For the bringing out of those finer points, which are nevertheless worthy of the farmer's notice, a technique involving the principles laid down in the conference is the safest basis for advisory work.

# THE NUTRITION OF THE CHICK AND ITS EFFECT ON GROWTH, MATURITY, EGG PRODUCTION AND MORTALITY.*

BY

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It is proposed to confine the scope of this paper to a discussion of some of the recent results of experimental work on the nutrition of chicks carried out at the Empire Marketing Board Poultry Research Station in Northern Ireland.

Investigations commenced in 1923 showed quite clearly that a great impetus to the growth rate could be given by the addition to a cereal ration of small quantities of mineral salts having a composition closely allied to that of the minerals in eggs, and that little or nothing was to be gained by adding to a normal chicken ration substances rich in vitamins. In 1925 the North of Ireland workers joined forces with Scotland and formed a joint committee for the better organisation of the work. The work of the committee undertaken at a number of centres in Scotland and in Northern Ireland demonstrated in a very striking manner that the addition of milk to a ration of mixed cereals doubled the rate of growth, and that for this purpose separated milk was as good as if not better than whole milk.

The experimental work summarised here† represents in the main a development and amplification of the work of the nutrition of poultry commenced by the joint committee of Scotland and Northern Ireland. The deliberate aim of the work in Northern Ireland has been the solution of practical problems as met with in the industry, and whatever fundamental value it may have accrues as a consequence and not as an object of the work.

The general principle underlying the whole of the work in Northern Ireland is that nutrition plays a far more important part in the growth and development of the birds, maturity, mortality and disease resistance, profitable disposal of surplus cockerels, egg production and the size of eggs of the pullet, than is generally realised, and that all these factors must be taken into consideration in measuring the significance and practical application of experimental rations.

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* Reprinted from Pamphlet No. 37 issued by the Ministry of Agriculture, Northern Ireland.

† A full account of the work will shortly be published in Vol. 3 of the Journal of the Ministry of Agriculture, Northern Ireland.

## The Effect of Nutrition on the Growth and Development of the Chick.

The object of the experimental work undertaken under this heading during 1928 may be stated as follows :—

(1) To determine the extent to which the remarkable growth results which follow the addition of separated milk to a cereal ration were due (*a*) to the mineral content of the milk and (*b*) to the protein content.

(2) To explore the possibilities of devising a ration consisting of cereals and protein and mineral-rich substances which would give results comparable to those obtained by the use of separated milk.

The arrangement of the experimental groups was as follows :—

| | | |
|---|---|---|
| Group A. | Basal mash : water to drink. | |
| Group B. | „ „ *plus* 3·75 per cent. Mineral Mixture : water to drink. | |
| Group C. | „ „ „ separated milk *ad lib* to drink. (No access to water.) | |
| Group F. | „ „ „ 5 per cent. Fish Meal. | Water only to drink. |
| Group G. | „ „ „ 6½ per cent. Soya Bean Meal and 3·1 per cent. Mineral Mixture. | Water only to drink. |
| Group H. | „ „ „ 2 per cent. Earthnut Cake meal. „ 2 per cent. Soya bean meal. „ 3 per cent. Linseed Cake meal. „ 3·1 per cent. Mineral mixture. | Water only to drink. |
| Group I. | Intensive mash. | |

The percentages stated are in terms of the mash fraction of the ration. Scratch grain was fed to all groups and represented approximately 50 per cent. of the total food consumed.

The cereal mash was composed of (parts by weight) Bran 2, Maize Meal 1, Sussex Ground Oats 1 and Sharps 1, and was fed dry in every case, and each group had an unlimited supply constantly before them. The composition of the mineral mixture* was based on the minerals in milk. The intensive mash fed to Group I was changed weekly for the first four weeks and was a modification of a ration reported as giving good results in the United States. It made its appeal because of its unorthodox nature. The approximate composition is set out in the following table :—

* Composition of mineral mixture : Steamed Bone Flour 72 per cent., Common Salt 11 per cent., Potassium Chloride 14¼ per cent., Sulphur 2 per cent., Ferric Oxide ¾ per cent., Potassium Iodide ·07 per cent.

TABLE I.

| | 1st week | 2nd week | 3rd and 4th weeks | 5th to 13th weeks | 14th week to 1st egg |
|---|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| Bran | 86·3 | 82 | 75·7 | 31·9 | 33·3 |
| Maize Meal | — | — | — | 10·5 | 33·3 |
| Sussex Ground Oats | — | — | — | 10·5 | 33·3 |
| Sharps | — | — | — | 10·5 | — |
| Fish Meal | 1·5 | 3·0 | 5·4 | 10·5 | — |
| Earthnut Cake Meal | 1·5 | 3·0 | 5·4 | 5·2 | — |
| Linseed Cake Meal | — | — | — | 5·2 | — |
| Dried Buttermilk | 9·2 | 9·2 | 8·1 | 10·5 | — |
| Steamed Bone Flour | 1·5 | 3·0 | 5·4 | 5·2 | — |

Pure bred White Wyandotte chicks have been used throughout the whole of the experimental work and the rations usually commenced when the chicks were four days old. In the various experiments the groups varied from 50 to 100 chicks each. Alternate grass runs each measuring 60 ft. by 37½ ft. were available for each group of chicks.

The chicks in the above groups were weighed at weekly intervals. A summary of the results is set out in Table II and illustrated in the chart on p. 556.

TABLE II.

| Group | Ration | Av weight at start one week old (grms.) | Av. weight in grams at end of 5th week | 9th week | 13th week |
|---|---|---|---|---|---|
| A | Basal (mixed cereals) | 45·0 | 128 | 339 | 663 |
| B | Basal plus Minerals | 45·0 | 192 | 631 | 1,159 |
| C | Basal plus Sep. Milk | 47·6 | 272 | 837 | 1,484 |
| F | Basal plus Fish Meal | 45·7 | 222 | 644 | 1,280 |
| G | Basal plus Soya Bean plus Minerals | 46·1 | 225 | 693 | 1,319 |
| H | Basal plus Mixed Vegetable protein plus minerals | 46·1 | 204 | 637 | 1,181 |
| I | Intensive Mash | 46·3 | 275 | 808 | 1,439 |

This particular experiment has in its main aspects been repeated several times in Northern Ireland and at each of the Scottish centres. The results illustrate :—

(1) the remarkable effect of the place of nutrition upon the growth and development of the birds (Groups C, I and A).

(2) the important part played by the mineral consituents of the ration (Group B).

(3) that the attempt to construct a ration which would give as good results as milk was completely successful in the case of Group I and only partially successful in the case of Groups F, G and H.

Subsequent work during 1929 was mainly concerned in separating out the factors responsible for the highly successful results obtained with the intensive mash fed to Group I, and with exploring the possibility of improving the results for Group G (soya bean meal) by increasing the proportion of extracted soya bean fed. The limitations set to a Congress paper make it impossible to detail the actual experiments. The intensive mash fed to Group I is obviously too complicated to be adopted in general practice and efforts were made to simplify it. The evidence shows that the high proportion of bran is neither necessary nor desirable and its substitution by a basal mash of mixed cereals such as the one quoted gives even better returns. It is, moreover, quite unnecessary to alter its constitution, week by week.

Attempts to improve the extracted soya bean ration fed to Group G were completely successful. Eighteen per cent. of soya bean meal added to the basal mash and minerals has given results equal to those obtained from the basal mash and separated milk and no digestive disturbances were experienced as a result of inducing chicks four days old to consume a mash containing 18 per cent. of extracted soya bean meal. The results from a typical experiment are given in Table III.

TABLE III.

*Average weight per chick in grams.*

| Age | Basal plus separated milk to drink. grams | Basal plus 4 per cent. Minerals plus 18 per cent. Soya Bean Meal : water to drink grams |
|---|---|---|
| 2 days . . . . . . . . | 46·7 | 44·6 |
| 5 weeks . . . . . . . . | 355 | 337 |
| 8 weeks . . . . . . . . | 900 | 869 |
| 12 weeks . . . . . . . . | 1359 | 1345 |
| Pullets only : 14 weeks . . . . . | 1414 | 1441 |
| 18½ weeks . . . . . | 1802 | 1831 |

RELATION OF NUTRITION TO MORTALITY RATE.

The relationship between nutrition and mortality is recognised generally but it is at least doubtful if its economic importance is appreciated fully. A complete mortality record has been kept of all the chicks hatched at the station, and the mortality rates of the various experimental groups reared during the past two years are set out in Table IV.

TABLE IV.

| Ration | No. of chickens on which percentage is based | Mortality % |
|---|---|---|
| Basal (cereals only) . . . . . . | 125 | 20·0 |
| Basal plus minerals . . . . . . | 195 | 13·3 |
| Basal plus milk . . . . . . . | 730 | 5·0 |
| Basal plus Soya Bean meal plus minerals . | 227 | 9·7 |
| Intensive mash . . . . . . . | 641 | 6·5 |

The differences shown in the table are sufficiently striking to require no comment. The comparison is probably not quite fair in the case of the chicks reared on the basal ration and soya bean meal because there is included in this group all the chicks reared on the rations containing varying proportions of

extracted soya bean meal (from 6½ to 18 per cent.). The group containing the lower proportion of extracted soya bean meal did not grow so well as and the losses were heavier than in groups reared on mashes containing 18 per cent. of soya bean meal.

## Relation of Nutrition to Maturity in the Pullet.

The influence of the several rations recorded above on the maturity of the pullets and on their weight at maturity is also very marked, as is shown in Table V.

Table V.

| Ration | Age when 1st egg laid | Average weight in grams when 1st egg laid |
|---|---|---|
| Basal | 186 days | 1,715 |
| Basal plus minerals | 146 ,, | 1,726 |
| Basal plus milk | 137 ,, | 1,830 |
| Basal plus soya bean plus minerals | 141 ,, | 1,809 |
| Intensive Ration | 135 ,, | 1,800 |

It is common knowledge amongst poultry keepers that the ration fed to the chick does influence the rate of maturity, but it is frequently assumed that pullets which are permitted to mature rapidly are undersized and underdeveloped, and that after the first few weeks it is desirable to slow down the rate of development. Such has not been our experience. The best fed groups have matured the most quickly, but, as will be seen from the table, they are the heaviest and the best developed birds and as will be shown later they have proved the best producers.

Attention should be drawn to one other interesting and important fact disclosed by the above table, namely, that it is the mineral, and not, as is frequently supposed, the protein content of the ration which determines the rate of maturity. That this is so is really not surprising when it is borne in mind that it is the "mineral fertilisers" and not nitrogen which accelerates the maturity or ripening of plants.

## The Effect of the Nutrition of the Chick on the Subsequent Egg Production of the Pullet.

The rearing rations fed to the pullets in the experimental groups A, B and C referred to were continued in the case of each group until the first egg was laid,

when the ration was immediately changed to a standard laying mash which will be continued for a period of two years. As the second year of the laying results are not yet available the results for the first complete year only have been tabulated. All the birds in each of the groups were trapnested throughout the entire period and each egg weighed individually.

TABLE VI.

| Groups | Ration on which pullets were reared | No. of pullets in group | Average No. of eggs laid per bird 1st September, 1928, 31st August, 1929 | Average weight of eggs in gms. | Average wholesale cash value of eggs per bird |
|---|---|---|---|---|---|
| | | | | | *s.* *d.* |
| A | Basal+water . . . . | 19 | 174·4 | 60·2 | 21 11 |
| B | Basal+Minerals+water to drink . | 18 | 207·8 | 57·3 | 26 1 |
| C | Basal+separated milk to drink . | 23 | 215·5 | 58·7 | 25 11 |
| F | Basal+5 per cent. Fish Meal . | 20 | 204·8 | 56·1 | 25 3 |
| G | Basal+6½ per cent. Soya Bean+Minerals. | 21 | 204·5 | 57·8 | 25 4 |
| I | Intensive Mash . . . . | 24 | 191·7 | 56·9 | 23 4 |

In the case of Group I, reared on the intensive mash, the experimental ration was withdrawn at the end of the 13 weeks and the pullets continued on the basal ration fed to Group A with the object of delaying maturity. Maturity was delayed, but as a consequence the birds matured at a lower body weight. With the same object the birds in Groups F, G and H were placed on the Group B mash (basal+minerals only) at the end of the 13th week. Maturity was not delayed and neither was the weight at maturity depressed.

The figures themselves emphasize adequately the benefits accruing from better rearing and do not confirm the view that it is a mistake to rear the pullets on what is termed a "forcing" ration. One of the most interesting features of the table is the excellent returns secured from the pullets reared on the basal ration+minerals (Group B).

THE EFFECT OF THE RATION ON THE DISPOSAL OF THE COCKERELS.

To obtain a complete picture of the effect of the various rearing rations it is necessary to explore their effect on the cockerels. It is our practice at the station

to dispose of all the surplus cockerels in the rearing groups at an average weight of approximately 3½ lbs. to a firm of intensive poultry fatteners. The position with regard to the cockerels is set out in Table VII.

TABLE VII.

| Group | Rearing ration | No. of days required to reach standard weight (3½ lbs.) | Actual average weight on receipt at fattening plant | Price per lb. received | Consumption per bird | Wholesale price received from Factory | Cost of Food per bird | Value less cost of food |
|---|---|---|---|---|---|---|---|---|
| | | | lbs. | d. | lbs. | d. | d. | d. |
| A | Basal . . . | 154 | 3·55 | 10 | 24·06 | 35·5 | 33·92 | 1·58 |
| B | Basal+Minerals . . | 105 | 3·63 | 13 | 16·25 | 47·2 | 23·4 | 23·80 |
| C | Basal+separated milk | 91 | 3·55 | 13 | *14·56 | 46·15 | 20·22 | 25·93 |
| F | Basal+Fish Meal . | 98 | 3·37 | 13 | 14·50 | 43·81 | 21·30 | 22·51 |
| G | Basal+Soya Bean + Minerals. | 98 | 3·55 | 13 | 13·98 | 46·15 | 20·18 | 25·97 |
| I | Intensive Mash . . | 91 | 3·62 | 13 | 14·18 | 47·06 | 25·25 | 21·85 |

* Including the milk consumed.

Here again comment appears to be superfluous. The cheapest ration, that is the basal ration, left only 1½*d*. per bird over the cost of the feed due to the lower price per lb., and the much longer time required to reach the 3½ lb. weight (154 days compared with 91) and the consequent much greater food consumption. On the other hand the basal and separated milk group (C) and the soya bean + mineral group (G) left a surplus of almost 2*s*. 2*d*. per bird over the cost of feed. The excellent results, obtained from the addition of a small quantity of minerals to the basal ration (Group B) is also noteworthy.

### INTENSIVE POULTRY FATTENING FOR TABLE PURPOSES—IS IT SOUND?

It has already been mentioned that the practice followed at the research station is to dispose of all surplus cockerels when they have reached a live weight of approximately 3½ lbs. The birds are sent to a firm of intensive poultry fatteners who condition them (trough feeding) for a period of 10-14 days in metal cage batteries, each battery holding 96 birds and each cage 6 birds. The practice of the firm is to buy chickens varying in weight from 3 to 4 lbs. from farms and poultry keepers and during the period of 10 to 14 days' fattening, an average of ½ a pound

is added to their live weight and the quality, tenderness and flavour of the dressed bird is consequently greatly improved. Through the courtesy of the firm facilities were put at our disposal for following out the subsequent history of several of our experimental groups and the information obtained during the 1928 season is set out below—

| Group | Rearing Station | Average weight on receipt at Factory | Average weight after 10 days intensive fattening | Gain + or loss — |
|---|---|---|---|---|
| | | lb. | lb. | Per cent. |
| C | Basal+separated milk . . | 3·55 | 3·44 | —3·1 |
| D | Ditto . . | 3·37 | 3·54 | +5·0 |
| E | Ditto . . | 3 48 | 3·60 | +3·4 |
| I | Intensive mash . . . | 3·62 | 3·79 | +4·7 |

The results from the fatteners' point of view were so disappointing that unfortunately all surplus cockerels from the remaining groups A, B, F, G and H were killed on receipt at the factory.

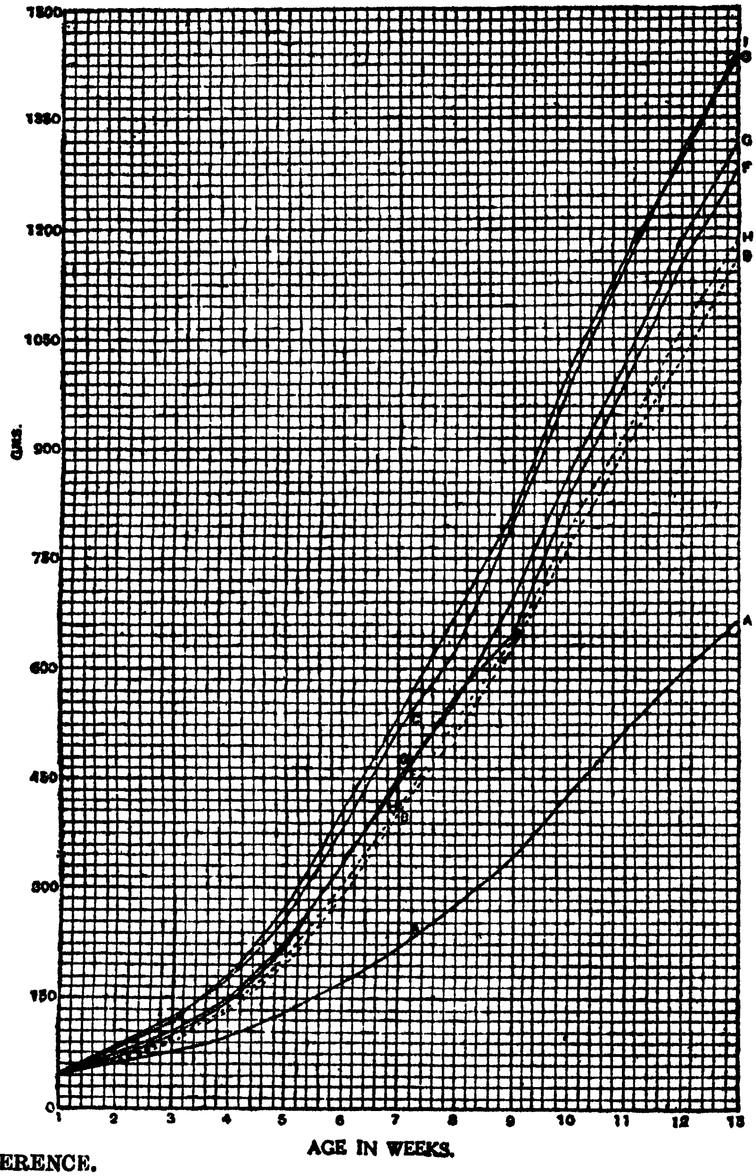
The information obtained is, however, of such a nature as to raise the whole question as to whether, if birds are properly reared, intensive fattening is sound practice. Accordingly during 1929 two further series of experiments were carried out. (1) A group of chickens 13 weeks old (both sexes), average weight 1,400 grms. (approximately 3 lbs.) was divided into two groups one of which was sent direct to the intensive fattening plant and the other retained in the plant and fed on their normal ration with free access to their grass runs. Particulars of the two groups and their live weight gains are set out below—

| Group | Age in days | Average weight per bird at start | No. of days feeding continued | Average weight per bird at end of period | Average gain per bird per day |
|---|---|---|---|---|---|
| | | gms. | | gms. | gms. |
| Research Station . . | 91 | 1,394 | 13 | 1599·4 | 15·8 |
| Intensive Poultry Fattening Plant. | 91 | 1,401 | 15 | 1590·0 | 12·6 |

(2) The second experiment consisted of a batch of chick 10 weeks old (both sexes) and weighing approximately 790 grams (1¾ lb.). As before, they were split into two groups, one being sent to the factory and the other retained at the station. As these were much younger and lighter birds, it was arranged that the factory would notify the research station of the day on which the experiment was to be discontinued. Unfortunately a delay occurred and the birds at the research station were not actually weighed out of the experiment until six days after the birds at the intensive poultry fattening plant had been killed. The results were as follows:—

| Group | Age in days | Average weight per bird at start | No. of days feeding continued | Average weight per bird at end of period | Average gain per bird per day |
|---|---|---|---|---|---|
| | | gms. | | gms. | gms. |
| Research Station . . . | 70 | 779 | 21 | 1250·9 | 21·9 |
| Intensive Poultry Fattening Plant | 70 | 761 | 15 | 948·5 | 12·5 |

So far as White Wyandottes are concerned it has not been possible to obtain any evidence that the intensive poultry fattening plant is capable of putting on live weight gains comparable with those that can be obtained with a proper ration fed under poultry farm conditions. The results seem to raise the question of whether the intensive poultry fattening plant is a necessary or desirable adjunct to the industry and we feel justified in suggesting that serious consideration should be given to the matter before any attempt is made in this country to develop intensive poultry fattening plants on similar lines to those in operation in Canada and the United States. In principle the intensive poultry fattening plant is illogical. Its industrial success is based mainly on the supply of "store" or badly reared chickens. The store chicken should disappear from poultry farming just as surely as the store pig has ceased to play any part in swine husbandry.




REFERENCE.

Lot A Basal Ration only.
Lot B " " +3 75% Minerals.
Lot C " " +Sep. Milk.
Lot F " " +5% Fish Meal.
Lot G " " +6·5% Soya+3·125% Minerals.
Lot H " " +2% Earthnut Cake Meal.
+3% Linseed " "
+2% Soya Bean Meal.
+3·125% Minerals.
Lot I Special Rations.

# AGRICULTURE IN RUSSIA.

(Reprinted from the *Journal of the Ministry of Agriculture*, Vol. XXXVIII, No. 3, June 1931.)

Widespread interest has been aroused by the resumption, during the current cereal year, of exports of corn from Russia on a substantial scale ; and the importance of the matter prompted the International Institute of Agriculture to undertake an examination of the available data to ascertain the nature of the changes that have taken place in Russian agriculture since the revolution, and the possibilities of further expansion in production and exports of corn. A summary of the results of this investigation was presented to the Preparatory Conference of the Second World Wheat Conference held towards the end of March last in Rome ; and, in the following paragraphs, an indication is given of a few of the more important features of this summary, amplified in certain directions by information from other sources.

In so far as Russian industrial activities are concerned it may be said briefly that the revolution resulted in the almost complete transference of control to the State. As regards agriculture, however, control for the most part still remained in private hands, and in consequence it was inevitable that difficulties would arise as between industrial and agricultural interests. These difficulties had several phases, starting with the forced requisitions of agricultural products during the period of so-called " War Communism " followed by the " New Economic Policy " that allowed greater freedom of action to the peasants, while a further phase may be said to have commenced with the putting into operation of " the Five-Year Plan ". This Five-Year Plan started with the economic year October, 1928, to September, 1929, and in regard to agriculture the plan provides for what is described as reorganization on a collective basis. The reorganization of agriculture is to be accomplished by the provision of large and increasing supplies of agricultural machinery and fertilizers in addition to the wide dissemination of technical and other propaganda, while " collectivization " involves the grouping together of the huge number of small peasant holdings. In this latter connexion it may be noted that, according to statistics relating to 1926-27, the total number of peasant holdings was then upwards of 24 millions, with an average sown area of only 9 acres. Of these holdings nearly one-fifth had a sown area of less than 3 acres, while at the other end of the scale only on 1·4 per cent. of the holdings did the area under crops exceed 43 acres.

The collectivization of agriculture is being carried on in two directions, *viz.*, by the establishment of State farms (sovkhoz) and of collective peasant farms (kol-

khoz). Among the State farms a number are organized especially for the purpose of cereal cultivation, to a large extent on fresh land. At the moment there exist 175 of these specialist cereal farms with a total area of approximately 30 million acres. As many as 50 of these have an area of over 250,000 acres each, while 4 exceed 500.000 acres each. It would appear that as yet these farms are not being utilized to their fullest extent, inasmuch as in 1931 the area sown is only expected to be about 13 million acres. That progress has been made, however, is indicated by the fact that the State farms as a whole are estimated to have accounted for 2·8 per cent. of the total area under cereals in 1930 compared with 1·2 per cent. in 1928, while in 1931 the proportion contributed by the State farms is expected to rise to 6·4 per cent.

Collective farms represent groups of individual peasant holdings operated as one farm. In all instances the land is the common property of the peasants concerned, but degrees of difference exist as to the extent of common ownership in the buildings and the live and dead stock, and as to the manner in which the results of the harvests are divided. Rapid increases have been recorded in " collectivization ", it being estimated that in 1929 some 15½ per cent. of the total number of holdings were in collective farms, in 1930 about 27½ per cent. Moreover, in the principal cereal-growing areas it is anticipated that in 1931 as many as 80 per cent. of the holdings will be in collective farms and that over the whole country in that year collective farms will contain nearly 41 per cent. of the total area under cereals.

Even before the operation of the Five Year Plan substantial increases had been recorded in the numbers of tractors in Russia, the total rising from under 3,000 in 1924 to nearly 32,000 in 1928. The majority of the machines were imported, the number manufactured in Russia being less than 4,000 in 1928, although it is anticipated that in 1932 it will be possible to provide nearly all the tractors required from home manufacture. In 1930 the power of the tractors available for agriculture was estimated at 900,000 horse power, while the corresponding figure for 1931 is stated to exceed 2 million horse power. For the most part these tractors are put at the disposal of " tractor-centres, " which contract with collective farms to do their ploughing, sowing, harvesting, etc. In payment the tractor centres receive one-quarter of the harvest, and in addition the collective farm has to undertake to deliver to the centre, at prices fixed by the State, the surplus balance of the harvest after deduction of any amounts required for food, etc., on the farm. According to the Five-Year Plan, by the sping of 1931, these tractor-centres were to number 1,105, with machines developing 692,000 h. p.

While the use of artificial fertilizers has made considerable progress it is still relatively limited, the total amount utilized being estimated at 665,000 tons in

1929-30, compared with 216,000 tons in 1927-28. At the same time it is anticipated that by the development of home resources the figures in 1931 will be increased to 2,400,000 tons.

In the foregoing paragraphs an attempt has been made to furnish a broad outline of the changes that have taken place in Russian agriculture in the direction of State control, and of the efforts that are being made to increase productivity and total yield. It now remains to deal with the actual area and production of cereals in Russia and the possibilities of the future.

The total area of Soviet Russia may be roughly classified as follows :—

| —— | Millions of acres | Proportion of total per cent. |
|---|---|---|
| Arable Land (including gardens) | 455 | 8·4 |
| Permanent Grass | 247 | 4·6 |
| Forests | 1,472 | 27·3 |
| Other Productive Land | 99 | 1·9 |
| Total Productive Land | 2,273 | 42·2 |
| Unproductive Land | 297 | 5·5 |
| Land not used for Agriculture | 2,131 | 39·5 |
| Land not classified | 689 | 12·8 |
| Total | 5,390 | 100·0 |

Rather over 40 per cent. of the total area falls under the heading of productive land, but of this nearly two-thirds is under forests, arable land representing somewhat more than one-half of the remainder. The bulk (about 370 million acres) of the arable land lies in the black soil belt, but the total area of this belt is estimated to be approximately 620 million acres, and there are, therefore, considerable possibilities of an extension of cultivation. At the same time it is necessary to remember that climatic conditions in large areas of the black soil belt are by no means very favourable for corn growing, inasmuch as the rainfall is often inadequate and periodic droughts occur. The remainder of the land included in the table above under the last two categories would appear, as a whole, to be unsuitable for crops, although in some degree lending itself to stock-raising.

Apart from the possibilities of increasing production by the cultivation of fresh land, it is of importance to note that over the greater part of Russia the predominant rotation is one of three years, with the land lying fallow every third year.

In consequence, about 30 per cent. of the arable area in the above table is fallow land, and the general adoption of a more modern system of farming would obviously enable the total output to be increased irrespective of any extension of the total area.

The progress that has so far been made in increasing the sown area is indicated by the following table :—

| Year | Cereals | Area sown-millions of acres | | Total |
|---|---|---|---|---|
| | | Industrial Crops | Other Crops | |
| 1925 . . . . . . . . | 220·1 | 17·7 | 24·8 | 262·6 |
| 1926 . . . . . . . . | 235·7 | 16·7 | 25·0 | 277·4 |
| 1927 . . . . . . . . | 239·8 | 17·8 | 26·5 | 284·1 |
| 1928 . . . . . . . . | 227·7 | 21·3 | 36·9 | 285·9 |
| 1929 . . . . . . . . | 237·2 | 21·8 | 38·3 | 297·3 |
| 1930 . . . . . . . . | 252·0 | 26·4 | 43·8 | 322·2 |

Over the whole period the area sown has risen by nearly 60 million acres or about 23 per cent. Rather over one-half of the increase in area has occurred in cereal cultivation, although it may be noted that proportionately by far the heaviest gains have been recorded in industrial and other crops. During the last two years shown in the table the rate of increase has tended to accelerate, a circumstance which must presumably be attributed to the operation of the Five-Year Plan, and in 1931 the total sown area is planned to reach 353 million acres of which cereal crops are to comprise 274 million acres.

According to Russian computations the area and production of the principal corps in 1930 were both much in advance of the 1913 level, with the single exception of barley. Much of the increased area under cereal crops has been devoted to wheat-growing, the area under wheat having risen from some 63 million acres in 1925 to 86 million in 1930. Further notable extensions to the wheat area are planned, and the total is to be increased to 101 million acres in 1931 and to 113 million acres in 1932. The area under barley, oats and maize has also been extended, but in the case of rye the area has been reduced. In 1929 some 64 million acres were under rye, 46 million under oats, 20 million under barley, and 9 million acres under maize.

The total yields of the principal cereal crops are given below :—

| Year | Wheat | Production in millions of cwt. | | | Maize |
|---|---|---|---|---|---|
| | | Rye | Barley | Oats | |
| 1925 | 419 | 453 | 115 | 239 | 86 |
| 1926 | 489 | 471 | 105 | 306 | 66 |
| 1927 | 416 | 481 | 89 | 262 | 68 |
| 1928 | 432 | 376 | 108 | 324 | 65 |
| 1929 | 382 | 398 | 145 | 327 | 83 |
| 1930* | 553 | ... | ... | ... | ... |

* The figure for wheat, which is provisional, is the only one so far available.

The table shows clearly the very marked increase that took place in the production of wheat in 1930, although before that year the rising area under wheat was not reflected in heavier production, owing to variations in the average yield per acre. In 1925 and 1926 the average yield of wheat per acre over the whole country was 6·6 cwt., but in 1927 it dropped to 5·3 cwt. per acre, and while the next year showed a recovery to 5·9 cwt., in 1929 there was a further reduction to 5 cwt. per acre only. The average yield in 1930 at 6·4 cwt. was again good, although slightly inferior to the yields of 1925 and 1926. Thus during a period of six years the highest figure was nearly one-third more than the lowest. Equally noticeable variations have occurred in the average yields of barely, oats and maize, although the yield of rye has been decidedly more stable.

With regard to other crops reference may be made to the important extensions that have been planned to take place in the areas devoted to sugar-beet, cotton, flax and tea. During 1931 the area under sugar-beet is to be raised to 3⅓ million acres, which would represent an increase on the year of 31 per cent. The probable production of beet is put at about 21 million tons, with a yield of very nearly 2¼ million tons of raw sugar as against less than 1⅔ million tons in the preceding season. Efforts are to be made to provide more beet-drying plants, and it is hoped thereby to extend the sugar-making season to 155 days compared with 80 to 120 days in recent seasons. The area devoted to cotton in 1931 is to be 5,700,000 acres, from which nearly 2 million tons of raw cotton are to be obtained, or nearly one-half as much again as the corresponding figure for 1930. The probable output of cotton fibre is put at about 660,000 tons. Compared with 1930 the area under flax is to be increased in 1931 by 14 per cent. to 5,200,000 acres, and in conse-

quence it is anticipated that the output of flax fibre will rise from 410,000 tons to 560,000 tons. In regard to tea it is proposed to plant in 1931 a further area of 33,000 acres and to prepare an additional area of 39,000 acres for the same purpose. State tea farms are to be organized on a large scale.

Turning to the live-stock side of the agricultural industry, the situation disclosed by the following figures of numbers of live-stock in Russia is in marked contrast to the position in arable farming.

| Year | Live-stock in Russia (Millions of heads). | | | |
|---|---|---|---|---|
| | Horses | Cattle | Sheep | Pigs |
| 1916 . . . . . . . . | 35·8 | 60·6 | 113·0 | 20·9 |
| 1924 . . . . . . . . | 24·7 | 56·7 | 95·1 | 21·3 |
| 1927 . . . . . . . . | 31·1 | 68·2 | 126·8 | 23·2 |
| 1928 . . . . . . . . | 33·5 | 70·7 | 133·6 | 26·1 |
| 1929 . . . . . . . . | 34·6 | 67·2 | 134·0 | 20·5 |
| 1930 . . . . . . . . | 31·2 | 53·8 | 100·6 | 13·2 |

Marked increases were recorded between 1924 and 1928, and in the latter year the numbers were, with the exception of horses, well above the totals in 1916. In 1929 further slight increases occurred in horses and sheep, but cattle and pigs declined in number, while in the next year all classes of live-stock suffered heavy reductions. As a result, the numbers of cattle and pigs in 1930 were much the smallest of the years covered by the table, while sheep were only slightly more numerous than in 1924. In commenting on these figures the International Institute of Agriculture ascribes the reductions mainly to the policy of collectivization, as a result of which the peasants slaughtered or sold for slaughter large numbers of animals. At the same time the Institute points out that fodder crops were poor in 1929 and in some areas in 1930 also.

It would appear that the Soviet authorities are taking steps to deal with the situation partly by restricting the slaughtering of young stock, and partly by establishing special State and collective farms for stock-raising. In the latter connexion it may be noted that in 1931 the numbers of live-stock on State farms are to be raised to 2,800,000 cattle, 4,400,000 sheep and 1,900,000 pigs, and those on collective farms to 4,000,000 cows, 9,000,000 sheep and 5,000,000 pigs (inclusive of 1,300,000 breeding sows).

Apart from the effect of any measures that may be taken to rehabilitate the live-stock industry, it will be clear from the earlier paragraphs that strenuous efforts have been and are being made to increase the cultivated area, particularly in regard to wheat growing. Moreover, the possibilities of extension appear to be considerable, partly through the breaking up of fresh land and partly by a modernization of the rotation. Probably of equal importance are the measures that are being taken to stimulate productivity by the increased use of machinery and fertilizers, and by the dissemination of propaganda. While variations in the yield per acre are marked, it is impossible to resist the conclusion that under normal climatic conditions large increases in output must be expected if the present programme is carried through. At the same time, in so far as exports are concerned it is necessary to remember that Russia has a rapidly increasing population—it rose from 132 millions in 1922 to 154 millions in 1929 and 158 millions in 1930—and that the consumption per head of the bread-making cereals, wheat and rye, is computed to be still somewhat below the pre-war level.

# STOCK-LICKS IN DRY SEASONS.

BY

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The aphorism "the soil is the child of the climate" has not received that general recognition in New Zealand which the truth warrants. It is more especially in the South Island that the influence of climates on the same soil-formers results in different types of farming developing in areas having different rainfalls, the soils being derived from rocks of the same composition originally. In the North Island droughty seasons occur in the Wairarapa and Hawke's Bay areas, and occasionally in Taranaki, but there is not the same constancy in climate that there is in the South Island.

A study of the local meteorology may reveal a reason for low returns from stock when other conditions of environment do not offer an explanation. It is from the soil that the pasture obtains those mineral foods so essential to both plant and animal. One of the most important constituents of the soil is water, which acts as a carrier of minerals from the soil to the plant. Pasture plants take up under favourable conditions much more mineral food than they require for healthy growth. This fact is utilized in farming to make the pasture convey more mineral food from the soil to the animal in a palatable form by top-dressing the pasture with mineral fertilizers. At the same time the pasture is made by this means more attractive and nutritious, and the production of pasture and therefore the carrying-capacity per acre is much increased.

Top-dressing mixtures do not, as at present used, intentionally include some mineral foods essential to the animal, because these do not increase production of pasture. It is customary to give such minerals to the animal direct as a stock-lick. Examples of these mineral foods benefiting the animal but not the plant are sodium and chlorine given as common salt (sodium chloride); iron—highly necessary in some sandy and perhaps peaty districts—given as citrate, carbonate, or hydrated oxide mixed with the salt; and iodine given in minute doses with the salt as potassium iodide. Special crops such as mangels, asparagus, and some others benefit by applications of salt as a manure, while potatoes and some other crops may

have iron sulphate and profit by it; but pasture is not in general practice dressed with salt or iron, although both may at times be applied as impurities in the fertilizer used—salt in kainit or potash manures, and iron in basic slag.

A somewhat sharp distinction may therefore be made in considering mineral foods between those which do increase production of pasture or carrying-capacity, and those which do not but are of primary value to the animal. Thus phosphates of calcium, which are the chief fertilizers used for New Zealand soils, are highly effective in increasing production and quality of pasture; and as these phosphates are an important animal requirement, it has become the fixed practice to give such phosphates through the grass to the animal, so initiating a beneficent cycle of improvement on the farm which finds immediate response in the well-being of pasture and animal. Should, however, droughty soil conditions occur as the result of an abnormally dry season (or it may be even the normal drought of summer is responsible but not recognized as an adverse factor) the pasture is unable to assimilate an excess of phosphate from the soil required by the animal, which suffers from mineral hunger, resulting in diminished production. If the starvation be prolonged or unusually severe in the case of phosphate-starvation, symptoms of malnutrition develop, the animal shows a craving for bones, etc., and ultimately becomes lame. It is then that remedies are first sought by the farmer, and the quickest relief is afforded by drenching the animal with some soluble phosphate, preferably (as originally demonstrated by Dr. C. J. Reakes) with syrup of phosphate of iron.

A striking instance of the close dependence of the nutritive value of pasture on rainfall was given in the last number of this *Journal*. In the Wairarapa, largely an inland district surrounded by mountains, meteorological conditions vary considerably from year to year, so that in three consecutive summers the phosphoric acid content of the pasture varied correspondingly with the changing amount of rainfall. As the nitrogen and therefore the protein content varies roughly with the phosphoric acid content, it will be seen that the nutritive value of a given weight of summer pasture is largely dependent on the rainfall. The lesson to be learnt from this truth is that a soil which in wet summers produces pasture with a fair amount of phosphoric acid may in dry summers provide insufficient to keep the production up to normal, and the nutritive value of the pasture may fall to a figure for protein one-half of that provided in a wet summer.

The remedy for mineral deficiency is simple enough, and there is a long series of experiments in drought-stricken lands to point the way. When the animal is unable to obtain sufficient phosphate from the pasture the obvious treatment is to give phosphates as a lick mixed with salt direct to the animal. There is evidence to show that of all phosphates bonedust is that from which the elements are most

readily absorbed by the animal. Any excess not utilized passes through the digestive system and is voided on the pasture, so that nothing is wasted. As an insurance, therefore, against lowered production due to phosphate hunger in droughty or abnormal seasons, or phosphate deficiency in the diet due to any other cause, the use of bonedust mixed with an equal weight of salt is recommended. Bonedust supplies both lime and phosphoric acid. In the event, therefore, of calcium being deficient in the food supply, bonedust may also supply this deficiency. If the animal gets low enough in condition, however, medicinal drenching is the appropriate remedy, as above stated.

Recent developments in bush-sick districts have shown the very great value of animal licks to supply iron deficient in the pasture direct to sheep and cattle. Iodine has been successfully used in lick form in the iodine-deficient districts of Lake Wanaka. Salt is universally recognized as a necessity for farm stock wherever the best results are desired. The extension of the salt-lick method to include phosphate is a logical development, and one which will overcome phosphate hunger caused by seasonal or abnormal droughts, which occurs in spite of top-dressing the pasture. The writer looks to the stock-lick to effect a great step forward in the pastoral development of this Dominion, and this method of improvement is all the more attractive owing to the comparatively low expense entailed.

# INTERNATIONAL WHEAT CONFERENCE, ROME.

(Reprinted from the *Journal of the Ministry of Agriculture*, Volume XXXVIII, No. 3, June 1931.)

The Preparatory Conference of the Second World Wheat Conference was held at Rome on March 26 last and subsequent days. Delegates attended on behalf of forty-six countries, including all the important wheat-producing countries, with the exception of the United States. The latter country was, however, represented by two unofficial experts invited by the International Institute of Agriculture.

The Delegation of the United Kingdom was constituted as follows: H. M. Ambassador at Rome, His Excellency the Rt. Hon. Sir Ronald Graham, G. C. M. G., G. C. V. O., C.B., Head of the Delegation, Sir A. Daniel Hall, K.C.B., LL.D., F.R.S., Chief Scientific Adviser to the Ministry of Agriculture and Fisheries, and Mr. C. Nathan, Principal in charge of the Ministry's Statistical Branch. In addition, Mr. Alexander Slater, President of the Liverpool Corn Trade Association, was present as an expert on the invitation of the International Institute, while Sir Herbert Robson, K.B.E., also attended as a representative of the London Corn Trade Association.

The proceedings were opened by His Excellency Signor Mussolini, and short formal addresses were then delivered by the principal delegates of Argentina, France, the United Kingdom, Hungary and Roumania, and by the representative of the League of Nations. After the appointment of His Excellency M. de Michelis, the President of the International Institute of Agriculture, as President of the Conference, a general discussion, lasting several days, of the problems before the Conference took place. During the discussion, in the course of which a considerable number of delegates expounded the views of their respective countries, it soon became clear :—

(*a*) that the claims of the exporting countries of Eastern and Central Europe for preferential treatment for their wheat would be unacceptable to the overseas exporting countries, and to a number of free trade importing countries of Western Europe ;

(*b*) that there was no hope of any general compulsory reduction of the wheat area ;

(*c*) that there was general agreement that a somewhat higher price for wheat would be of advantage not only to exporting countries but also, in the long run, to importing countries.

In the course of the discussions Sir Denial Hall spoke on behalf of the United Kingdom Delegation, and stated that His Majesty's Government viewed with grave concern the continued fall in the price of wheat which had created so grave a situation not only for so many farmers in Great Britain, but also for farmers in the Dominions as well as those of Eastern Europe. On the other hand, the speaker pointed out, with regard to any system of preferential agreements between these eastern exporting countries and countries of Western Europe, H. M. Government must reserve its opinion, especially if any interference with the most-favoured nation clauses is proposed. In continuation, Sir Daniel Hall said that while there had unquestionably been an abnormal surplus production of wheat in 1928, it was doubtful whether the average production was in excess of requirements. On the average of recent years, production has only kept pace with the growth of population, and the recent break in wheat prices was to a large extent part of the general economic depression. Any artificial restriction of production might therefore result in a dangerous scarcity should crop failures occur simultaneously in more than one exporting country. The remedy for the present crisis was an improvement in the general economic situation with a consequent increase of wheat consumption, the removal of the various barriers to wheat importation existing in many importing countries, and the stimulation of the demand for wheat in the Orient.

On the conclusion of the general discussions the Conference resolved into the following three Committees :—

(a) Production and Trade.

(b) International Agricultural Credit.

(c) Preferential Tariffs.

When the work of the three Committees was completed, a draft Final Act was prepared for submission to the Plenary Conference. The resolutions embodied in the draft Final Act were approved by the Conference after slight amendment, and the text of the resolutions in their final form is appended :—

## I.—International Organization of Wheat Production and of the Wheat Trade.

(1) The International Preparatory Conference of the Second Wheat Conference recommends examination of the possibility, in countries where wheat is already consumed, of considering the means of developing such consumption. It also recommends a strong publicity campaign in order to popularize the consumption of wheat in countries where it is not at present largely used. It is of opinion that in order to give full effect to this publicity, it would be desirable to sell off, at low prices in such countries, part of the stocks which overburden the world market.

(2) It recognizes that the European countries, for manifold reasons, economic, social or political, are unable either to give up the cultivation of wheat or to allow it to be neglected.

(3) It recognizes that it is impossible to secure a general reduction in the areas sown throughout the world by the direct method of obligatory restriction, whether advocated by an international body or by national bodies.

It is convinced that the reduction of sowings can only be obtained by natural methods, by the farmers themselves, influenced by the conditions of the market and a study of the figures and of the facts.

It recommends that in countries which consider it advisable this influence should be reinforced by an educational propaganda among the producers.

(4) The Conference considers that, in order to secure the solution of the wheat crisis, it is particularly necessary that there should be an improved organization of the wheat market. Such organization should be brought about rather by a gradual and progressive policy, based step by step on the results obtained, than by any policy that claims to cover every aspect of the problem.

In order to reach a rapid solution, it recommends the countries interested to concentrate their efforts for the present on some particular definite and limited object, such as the disposal or the organization of the carry-over of existing stocks.

(5) The Conference is glad to note that the wheat exporting countries, Overseas and European, have decided to draw up together a scheme to deal with the wheat export season 1931-32 and with existing stocks, and that they will meet for this purpose, under the presidency of the Hon. George Howard Ferguson, High Commissioner of Canada, in London, on May 18.

(6) At the same time the Conference recommends the different buyers in those importing countries where the need should make itself felt to endeavour to form organizations for the purchase of imported wheats. Such organizations may take any form whatever which may be suitable in view of the particular situation in each country.

(7) The Conference considers that the International Institute of Agriculture and the Economic Organization of the League of Nations should follow closely the efforts to be made by the various countries in the sphere of wheat production and trade, in order to be in a position to take in full agreement such steps as current experience may suggest.

(8) It considers that the improvement of the organization of world wheat production and trade largely depends on an improvement in the provision of information and of statistical forecasts.

It expresses its confidence in the International Institute of Agriculture as a means for co-ordinating the statistical data of the various countries in this respect, for checking and interpreting the figures, for supplementing the documentation from official sources by such professional or commercial documentation as may throw light on the problem, for facilitating the utilization of statistical information and for making it available without delay to the interested parties.

The Conference recommends all the States to increase the financial resources available for the International Institute of Agriculture, in order to enable the Institute to carry out this work to best advantage.

## II.—International Agricultural Credit.

(1) The Preparatory Conference of the Second World Wheat Conference has examined with special attention the part which a systematic organisation of agricultural credit can play in improving the general situation of agriculture and, in particular, in overcoming the grain crisis.

It is of opinion that it is more than ever necessary to be able to obtain for farmers, and in particular for wheat growers, at low rates of interest, the capital of which they have need, and that, with that object, it is desirable to examine from an international point of view, the question of agricultural credit, which differs from commercial credit in the forms imposed upon it by the special conditions of agricultural production.

(2) With regard to medium-term and long-term credit, which serves principally to enable farmers to purchase equipment and stock, to acquire or to enlarge a holding, to carry out land improvement and to effect transformations in systems of cultivation, in order to restrict, when desirable and possible, the area sown to cereals and to develop the cultivation of crops which can advantageously replace them, the Conference is pleased to learn that the Financial Committee of the League of Nations, taking account of the studies made by the International Institute of Agriculture, is at present contemplating the formation of an international mortgage credit institution.

It expresses the wish that this organisation should as quickly as possible be in a position to supply, at the most favourable rates, medium-term and long-term credit to the farmers of all countries.

The Conference is of opinion that medium-term and long-term credit are as useful to corporate bodies as to individuals and that it should also serve to facilitate the construction of elevators, of silos and of co-operative warehouses, and the organization of co-operative societies for the marketing of grain and of other agricultural products.

The Conference points out that medium-term credit can also be useful to farmers who are not the owners of their farms as, in default of mortgages, they can give other effective security, such as agricultural warrants, liens on crops, sureties, or joint and several guarantees.

(3) The Conference notes that in the present crisis, short-term agricultural credit is of particular importance and that it should be encouraged as much as possible by the Governments of the different countries.

This form of credit, in fact, can enable farmers and particularly grain growers to avoid hasty sales immediately after the harvest which lower and disturb the course of prices, to the detriment of the producer and without benefit to the consumer. By facilitating the substitution of other crops for wheat, and systematic and orderly marketing by individual farmers as well as by co-operative societies, short-term agricultural credit can contribute to a rationalization of production, to a greater stabilization of prices, and to a better organization of exports and of markets.

In this regard, the Conference is of opinion that the transfer of capital may advantageously take place between countries where it is plentiful and cheap and those where it is scarce and costly, and that it is necessary to study the means of facilitating such transfer of capital on an international scale in order to develop short-term agricultural credit in all countries.

(4) The Conference again expresses the opinion that it is desirable to provide exporters with the credit necessary for speeding up the clearance of stocks and that in particular transport agencies, bonded and general warehouses and shipping companies might with advantage intervene here by utilizing the credit which such bodies have already at command.

Thus as proposed by the Committee established by the Commission for the study of the question of European Union, it might become possible to consider for the purpose of discounting bills a fuller utilization of those markets on which the rate of interest is low, the issue of warrants on merchantable products, and the possible introduction of the system of a negotiable way-bill.

(5) The Conference requests the International Institute of Agriculture to continue its studies relating to agricultural credit, and to endeavour to draw up a general scheme for the organization of short-term agricultural credit.

III. Preferential Tariff System.

The Conference has noted that the discussion on the preferential tariff system, which took place in the Commission appointed to consider this question, was based on an appendix to the report of a Commission of the Second Conference in favour of a concerted economic policy, which met at Geneva in November, 1930. The discussion has been carried as far as is at present possible in the field of multilateral conversations.

The principal difficulty encountered by the Commission lay in the fact that the delegates of several important wheat exporting countries declared that they did not possess the materials necessary to enable them to estimate the possible loss which they might suffer as a result of the preferential system, nor the possible advantages that they might be able to derive therefrom.

Hence, if the interested countries, who are prepared to make trade agreements on a preferential basis, desire to continue the discussion, it will be necessary for them to have recourse to diplomatic channels.

The Commission also ascertained that all exporting countries have the same interest, in so far as they all desire to see the European market strengthened, so that they may obtain remunerative prices for their cereals.

The above resolutions were approved unanimously by the conference except that the Russian delegation reserved its approval in the case of Resolutions 1 and 7 of Part I and voted against Parts II and III.

Probably the most important result of the Conference was the decision taken by the representatives of exporting countries, both European and overseas, to meet in London last month under the chairmanship of the High Commissioner for Canada, to attempt to formulate an agreed plan for the liquidation of existing stocks and of any surpluses from the crops to be harvested in 1931-32: It will also be noted that there was general agreement as to the impossibility of achieving compulsory restriction of area, and as to the need of propaganda for increasing consumption, although in regard to the latter question the representatives of Germany, France and Italy stated that for reasons of internal policy their countries could modify neither their tariffs nor their requirements, as to the minimum proportion of native wheat milled. No resolution was passed concerning the proposal of the exporting countries of Eastern and Central Europe that their wheat should be granted preference by European importing countries, it being agreed that this proposal must be dealt with through diplomatic channels.

# EFFECT OF CLEANING ON HATCHING-QUALITY OF EGGS.

BY

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The question as to whether the cleaning of soiled or dirty eggs with a damp cloth injures their hatching-qualities is a debatable one among poultry-keepers. In an endeavour to throw some light on this matter an experiment was recently conducted at the Wallaceville Poultry Station with two lots of eggs, the first cleaned by means of a damp cloth, and the others left in the condition as taken from the nest, excepting that any thick dirt adhering was scraped off with a knife.

Two hundred and eighty-eight cleaned eggs were placed on two incubator trays, while a similar number not cleaned were placed on two other trays. These trays were placed in an incubator, the cleaned and uncleaned lots alternating. Two tested thermometers were used, one on the cleaned eggs and the other on the uncleaned. The incubator was managed in all respects according to the usual practice of this Station. None of the eggs were more than four days old when set.

The eggs were turned twice daily after the third day, and at each turning the position of the trays in the incubator was changed. The eggs were tested on the seventh day of incubation, when seventy-eight of the cleaned eggs and forty-three of the uncleaned were removed from the incubator. Of the cleaned lot forty-three contained dead germs and thirty-five proved infertile, while of the uncleaned, fifteen contained dead germs and twenty-eight were infertile. When testing some of the eggs during the various stages of the incubation process the germ in the uncleaned eggs generally appeared to be stronger than those contained in the cleaned lot.

During the first week both thermometers registered an even degree of temperature—namely, 102° F.—but from then onward to the pipping stage it was observed that the temperatures registered varied slightly. The thermometer on the cleaned eggs showed lower reading of about half a degree and this quite irrespective of the position of the trays in the incubator.

The second test was made on the fourteenth day, when twelve of the cleaned and five of the uncleaned eggs were found to contain dead germs and were removed from the incubator.

In most cases the air-cell in the uncleaned eggs dried down to a more desirable line than was the case in the cleaned eggs, while the chicks contained in the latter took from ten to twelve hours longer to hatch out. The uncleaned eggs commenced to pip on the twentieth day, while the cleaned ones showed no signs of pipping until well into the twenty-first day. The incubator was opened on the twenty-third day, when it was disclosed that 106 of the cleaned eggs had failed to hatch, as against sixty-two of the uncleaned. Eight deformed chicks were produced from the cleaned eggs, but none from those uncleaned.

This one experiment does not warrant the expression of a definite opinion regarding the particular way or ways in which cleaning of the eggs with a damp cloth had the undesirable effect on their hatching qualities; this also applies to the failure of the air-cell in the cleaned eggs to dry down to the desired line. The experiment, however, clearly indicates that better results can be secured from uncleaned eggs when subjected to artificial incubation than from eggs cleaned by means of a damp cloth. It is intended to repeat the experiment in due course.

# THE IMPORTANCE OF THE EGG IN INCUBATION.

BY

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Good results in incubation will not be secured unless the egg answers all requirements as to freshness, strength of fertilization, physical texture and condition.

Contrary to what is usually supposed—it is not necessary for the egg to be absolutely fresh in order to obtain good hatching results. But what is essential is that the eggs in any clutch should be as near to the same age as is possible. A certain reasonableness has to be observed. The eggs should be as fresh as possible, but good results can be obtained from eggs up to a fortnight old, providing that they are of approximately the same age, and have been properly stored and turned. Obviously, the fresher the egg the better, but the point is that eggs need not be refused for incubation if the first period of freshness is passed. Provided that they have been properly stored and can be incubated with eggs of similar age, good results will be obtained up to the period stated.

It might be of interest to glance at the underlying reasons for this. It is a mistake to assume that the egg consists of so much dead and inert material. The egg, *i.e.*, the fertilized egg, is actually alive. What really happens is that fertilization takes place when the ripe yolk drops from the ovary of the hen. From that point the life of the new chick starts. During the thirteen hours whilst it is retained in the mother bird's body and while the various layers of white and shell are being added, considerable development takes place in the germ. For instance, it will be settled whether a little pullet or a little cockerel will hatch from the egg, there will have been a considerable amount of cell division, and when the egg is laid, all that happens is thatt he growth of that little life is suspended. It is resumed again when the egg is brought under conditions comparable with those of the mother bird's body, so that when eggs are put into an incubator, incubation does not start—it is just resumed.

It follows, then, that the fresher the egg, the quicker will be the resumption of incubation. If an egg could be placed straight from the mother bird into the

incubator, it would hatch in about twenty days. On the other hand, if a week elapsed it would take at least twenty-four hours for the egg to warm up properly, and the full twenty-one days would be required for incubation. This period would be slightly extended as the age of the egg increased. This is the reason why hens who steal their nests so often bring back good hatches. It is not, as is commonly supposed, owing to the action of the humidity of the earth, it is owing to the fact that each day or couple of days the hen returns to her nest to lay another egg, and in doing that warms all the eggs which are there, keeping the clutch in good hatching condition.

Bad hatches can often be attributed to the fact that this element of freshness has been forgotten. Eggs of varying ages are put into the machine with the result that the fresher eggs hatch first and in hatching, upset the temperature and humidity of the machine, with detrimental effects on those eggs which are still to hatch.

On the question of fertilization it is generally agreed amongst the practical poultry-men, that the influence of the male bird is all important. Weakly fertilized eggs can nearly always be attributed to the male. But the reasons for this are not always clearly understood. Underfeeding of the cock bird is one of the most important reasons for this. It can be taken as certain that the better the bird, the more liable he is to neglect himself in favour of the hens at feeding time. Whilst individual feeding of the male is not always practicable it is desirable to watch this point and to give supplementary feeding to those birds heading breeding pens, which are losing condition.

Equally important is the influence of body parasites on the males. These, by irritation, cause a drop in vitality, which results in poorly fertilized eggs, and on some of the biggest poultry farms in England, it is a routine matter to inspect all the males for body parasites during the breeding season. Every breeding pen should be supplied with a dust bath in order that this particular trouble can be prevented. Where a natural dust bath is not available, a good substitute can be made by mixing nine pounds of fine dry sawdust or fine sand, with one pound of Izal powder.

Other reasons for low fertility will be found in the too fat condition of the birds, red mites, fleas, unsuitable diet and close confinement. But the two causes which have been elaborated probably account for the biggest part of the trouble in this respect.

Strong fertilization is obviously of no use if the contents and texture of the egg are not what they should be. Here again considerable misapprehension exists as to what is really required. In "Nature's" scheme of things, there is no such thing as

the edible egg. It is only as a potential chick that the egg has any value. Consequently it is nature's task to see that the egg is stored with sufficient food material to last the chick during development, and until it can fend for itself. All this food material is stored in the egg from the blood stream of the mother hen, and once the egg is laid no further addition can be made to it.

The actual analysis of the egg is, therefore, of very little use to us. From one point of view the percentage of water, etc., is no doubt important and interesting. But from the point of view of incubation we are much more interested in the egg's content from the point of view of the developing germ. What food it requires must be there for it is cut off completely from the mother's body. Broadly speaking, our main interest centres in the fat and mineral content of the egg, and it is these elements which are most often deficient in eggs for incubation and the shortage arises not so much from unsuitable diet fed to the mother hen before she lays the egg as from faulty matabolism. It is a well-known fact, however, that the hen will draw on her own body supplies almost to a point of exhaustion before any deficiency is noticed in the egg itself.

The question of body condition and food assimilation, however, is not so simple as it looks. If the fat and mineral contents of the egg are primarily important then we need to see that the fat and mineral assimilation of the hen is working at full efficiency. It is not enough to feed the hen with minerals and fat-forming substances. We must ensure correct assimilation. This is particularly true of the most important item of all, *viz.*. lime. In the absence of succulent green food, lime assimilation is nearly always below what it should be, and if healthy, vigorous chicks are required, the breeding stock must have all the succulent green food they will eat. In this connection it must be remembered that dry green food is not a good substitute. Green food intended for breeding stock must be succulent and contain within itself the natural moisture of the vegetable tissue.

The part that the egg plays in the spread of infantile disease, always arouses a good deal of interest and curiosity. But it is to be feared that most of the information published is ill-advised.

Broadly speaking, with the one exception of the dreaded B. W. D., it is very questionable whether any disease can be spread through the egg, although there is slight evidence that cocoidiosis is sometimes transmitted in this way. With B. W. D., however, the case is very different, and it is generally through infected eggs that this disease comes. Therefore, the only sensible precaution is a thorough blood testing of all the stock birds in stock at proper intervals, and a thorough disinfection of all incubators, brooders, etc., between each hatch, and the destruction of all infected material.

Disease can be much more easily spread to the chick through the organisms on the surface of the shell, and when we remember that the vagina and the end of the bowel both open into the same passage just inside the vent, we shall see how easy it is for the shell of an egg to become contaminated with the organisms of disease.

Therefore, as far as hatching eggs are concerned, where any possibility of disease exists, each egg should be wiped over with a damp cloth, dipped in a solution of one tablespoonful of Izal to a quart of water. This will remove and destroy any disease organisms that may be on the surface of the shell and this combined with a thorough spraying of the incubator between each hatch will remove all possibility of disease from this particular source.

# ABSTRACTS

**Rice breeding in the Central Provinces.** MAHTA, D. N. AND DAVE, B. B. (*Ind. J. Agric. Science* **1**, 351).

Rice is an important crop of the Central Provinces but as grown at present, it consists, generally speaking of a mixture of strains of different cropping power and quality.

The work of improvement has been largely concerned with the isolation of selected varieties and their improvement by raising high-yielding strains from single-plant selections and the raising of new useful strains by hybridisation. A number of useful varieties have been isolated and single-plant selection work in these has given such useful strains as Bhata-gurmatia 4, E. B. 17, Bhondu 10, Parewa 22, Gurmatia 17, Luchai 4, Chinoor 21 and Dilbuksha 35, all of which show better performance in the field.

It has been possible to devise a system of classification—based upon grain and leaf-sheath characters—wherein all the rice varieties can be placed, thus rendering easy further breeding work on this crop.

The chief success in the hybridisation work lies in the fixing of hybrids B. × P. No. 22; B. and P. No. 12 and B. × S. No. 24 possessing the characteristic of being readily distinguished from the wild rices which infest the rice fields of the cultivators, while at the same time comparing favourably in yield with some of the best varieties.

A brief history and yield tests by the Latin Square method of these two crosses have been given and a statistical treatment of the subject has been added as an appendix. [D. N. M.]

**Some observations on bamboos.** K. L. KHANNA. (*Ind. J. Agric. Science* **1**, 474.)

Flowering in bamboos is rare and occurs only at intervals of many years. A few clumps at different places in Pusa flowered in 1930 and observations have been recorded in this paper on their flowering; the nature of their seed; mode of underground branching and the type of root system at different stages of the plant's growth. The value of the rhizome as a reserve of plant food and as giving a gregarious plant like bamboo a stronghold in the soil, is also discussed. [K. L. K.].

**A cytological study of Capsicum annuum.** P. D. DIXIT. (*Ind. J. Agric. Science* **1**, 419.)

1. The diploid number of chromosomes in *Capsicum annuum* is 24.

2. The nucleolus during the prophases of mitosis gradually increases in size. It gives only a slight reaction for chromatin when the Linin network becomes prominent and takes up a dark stain.

3. The nucleolus is intimately concerned in the formation of chromosomes, it puts forth a small protuberance which joins the spireme and through this protuberance the chromatic material stored in the nucleolus is possibly transferred to the chromosomes.

4. The nuclear membrane appears to be formed from the periphery of the outer chromosomes and is used up when they are being formed.

5. The cell plate is continually extended at its free margins by means of the Kinoplasmic ring until it finally cuts completely across the cell.

6. A modification of Haematoxylin-balsam-smear method as used for the study of chromosome numbers in pollen grains is described in detail in the text.

7. The haploid number of chromosomes is twelve as reported by Huskins and Lacour and not six as mentioned by Kostoff.

8. Simultaneous and successive divisions take place in the different microspore mother cell giving rise to tetrahedral arrangements of microspores in some and bilateral in others, although the former is more common. [P. D. D.]

## Studies in Indian tobaccos, No. 6. The improvement of Indian cigarette tobacco by hybridization. KASHI RAM. (*Ind. J. Agric. Science* **1**, 455.)

The tobacco crop sown as early as 15th July in Bihar grows well but it is susceptible to "leaf spot" and "Curly disease", whereas a crop sown later than the first week of August does not suffer so heavily from these diseases but gives a somewhat smaller yield of leaf. These differences are more pronounced when the tobacco is an imported exotic variety such as Adcock. The indigenous types of Indian tobacco are hardy and heavy yielders but none are good in quality for cigarette manufacture.

In order to produce a variety of tobacco which while retaining the hardy growing characters of an indegenous type, may also be better in quality from the point of view of cigarette manufacture, the local Type 28 was crossed with Adcock.

In general vigour the $F_1$ plants were intermediate between the two parents and neither was completely dominant over the other.

In $F_2$ the range of variation was greatly extended and the co-efficient of variation was more than twice that of either parent. The $F_2$ generation was of great complexity, the true parental types did not reappear in $F_2$ and new characters not present in either parent appeared. The appearance in $F_2$ of a variety with large absolutely white flowers was very interesting as the flower colour of both the parents used in the cross was pink.

The ten newly produced hybrids have been obtained in a homozygous condition and are now breeding true. These hybrids are now being tested for their leaf quality both by ground curing and flue-curing methods. The preliminary test with one hybrid 8 (177) has given encouraging results. [K. R.]

## A study of causes contributing to the large variations in yields from year to year of 4 F cotton in the Punjab. TREVOR TROUGHT. (*Ind. J. Agric. Science* **1**, 310.)

The extent to which 'bad boll opening' is present throughout the area determines the extent to which a year is a 'failure' year, or a 'good' year; and is also assumed to be the

reason of yield variations. The symptoms of the 'failures' are described. The part diseases or insect pests may play in the incidence of these yield variations is considered to be secondary.

The effect of climatic and physiological factors are described and the importance of root development is emphasised.

The deduction is drawn that in failure years the overlapping effect of a series of adverse factors operating at comparatively short intervals of time, do not permit of the recovery of the plant before it matures its crop, and results in the failure of the plant to produce properly developed lint and seed. The plant is most susceptible in its early stages, at which time adverse factors are at their maximum. The factors react on root development reducing it from its optimum.

The adoption of good agricultural practice will assist in mitigating the effect of these adverse factors, but a complete solution can probably only be obtained by the discovery of a type of plant still more resistant to the severe climatic conditions which prevail. [T. T.]

**Annual outbreaks of rusts on wheat and barley in the plains of India.*** K. C. MEHTA. (*Ind. J. Agric. Science* **1,** 297.)

Wheat in Inbia suffers from all the three rusts (Vern. *ratua or gherui*) known on that host. The yellow and black rusts are also found on barley.

On the plains of India there is very little of the viable material of rusts available at the time of the harvest (March-April). It is almost impossible, on account of the intensely hot weather which follows the harvest, that rusts should oversummer on the plains of India. Consequently there is no local source of infection, as far as the plains are concerned, at the time when the crops are sown (October-November).

It is natural therefore that normally for 2-3 months each year after the sowing, the crops on the plains should keep rust-free.

After seven years' study of the problem the writer feels convinced that the foci of infection in the case of all the rusts under report lie in the hills.

On account of a comparatively cool summer, rusts survive in the uredo-stage on self-sown plants and tillers in the hills year after year.

Outbreaks of yellow rust have been found to occur on crops as early as January at Muktesar (nearly 7,600 ft. above sea-level) and this rust probably spreads to the plains by wind-blown uredospores from localities similarly situated.

With regard to brown and black rusts it seems probable that they disseminate to the plains from lower altitudes. [K. C. M.]

**The cereal-rust problem in India.** K. C. MEHTA. (*Ind. J. Agric. Science* **1,** 302.)

In India there are on an average 30,500,000 acres under wheat and 7,000,000 acres under barley each year. The damage done by rusts of wheat alone amounts to Rs. 40,000,000 or so annually.

* Abstract of a paper read by invitation at the Mycology and Plant Pathology Section of the Fifth International Botanical Congress held at Cambridge in August 1930.

Data obtained so far clearly indicate that in this country rusts are perpetuated from season to season largely by their uredospores which oversummer in the hills.

Outbreaks of yellow rust as early as December-January at higher altitudes suggest the probability of its dissemination to the plains by wind-blown uredospores.

In the case of brown and black rusts, the source of infection seems to spread from lower altitude, where both these rusts can survive during winter.

Consequently, the cultivation of only resistant varieties in the hills should check outbreaks of rust epidemics at those localities and the damage to crops on the plains should thereby be reduced considerably.

In order to breed varieties suitable for cultivation a thorough knowledge of "physiologic forms" of rusts and their regional distribution is indispensable.

Survey of rusts extended over a number of years with special reference to their alternate hosts, occurring in the hills, and also of localities in the different hilly tracts of the country, where rusts can oversummer, should lead to results of great value towards the adoption of measures of control. [K. C. M.]

**A note on an apparatus for catching spores from the upper air.*** G. CHATTERJEE. (*Ind. J. Agric. Science* **1**, 306.)

A slide with a smeared glass slide is sent up with a balloon that automatically deflates itself and begins to come down after reaching a predetermined height.

A cylindrical slide carrier whose ends can be simultaneously closed by two discs is sent up in a light bamboo cage with the ends of the slide carrier uncovered and facing the vertical; thus the slide held lengthwise at the centre is exposed to the downward draught of air caused by the ascent of the balloon. The discs, under the tension of a rubber band, fly back, cover the ends of the slide carrier and are locked in position by a spring catch, when withdrawn and released. A thread passing through a lighted and timed slow-fuse withholds the discs from closing the ends till it is burnt shortly before the balloon begins its descent.

In a label attached to the bamboo cage is announced a reward to the finder of the balloon and the instrument on their being delivered to a stated address. This enables the instruments or at least a fair number of them being retrieved.

The height up to which the slide is expose can be determined from certain theodolite observations taken during the flight. [G. C.]

**The influence of alkali salts on nitrification in some Indian soils.** J. H. WALTON. (*Ind. J. Agric. Science* **1**, 481.)

Varying quantities of carbonate, chloride and sulphate of sodium were added to several Indian soils from different localities, and their effects on the nitrification of ammonium sulphate

* The "spore trap" described above and published in the June (1931) number of the *Ind. Journ. Agric. Sc.* was used for catching rust spores from the upper air, in connection with the study of rust dissemination which is being carried out by Professor K. C. Mehta under the auspices of the Imperial Council of Agricultural Research.

and cake observed. Except in Pusa soil, 0·2 per cent. of sodium chloride or sulphate depressed nitrification. The results with sodium carbonate depended on to the nature of the soil to which it was added.

**Possible losses of fertilising constituents in the manuring of paddy.** J. CHARLTON. (*Ind. J. Agric. Science* **1**, 372.)

Manuring light paddy soils in heavy rainfall districts in Burma with ammonium phosphate manures, such as Leunaphos and Diammonphos, has failed to give results such as are obtained on the ordinary Delta soils with rainfall of 100″ p. a. or less. In a laboratory investigation it was found that paddy soils absorbed phosphate from solutions almost completely but ammonia was not so completely absorbed, especially by the light soils from heavy rainfall districts. Manuring such soils with organic manures in amounts such as are ordinarily available had little or no effect towards reducing possible losses. The absorption of ammonia by the soil depends upon the actual replaceable bases present and their relative amounts as well as on their total amount and it appears that ammonia is more easily exchanged for monovalent (Na & K) than for divalent replaceable bases. Concurrently with the better retention of ammonia by increasing the amounts of monovalent bases (Na & K), the possibility of loss of phosphate increased. Means of keeping these possible losses to a minimum are suggested. [J. C.]

**The colon bacteria occurring in the milk supply at Pusa.** J. H. WALTON. (*Ind. J. Agric. Science* **1**, 221.)

In the rainy season, from June to September, the predominating type was *Aerobacter*, which gives a positive Voges Proskauer reaction. In the other months *Escherischia* forms, giving a negative Voges Proskauer reaction were the most numerous.

**Some digestibility trials on Indian feeding stuffs, Part VII. "Kangra rice Straw".** P. E. LANDER AND PT. LAL CHAND DHARMANI. (*Ind. J. Vet. Science and Animal Husbandry* **1**, 177.)

This paper gives an account of the digestibility trials conducted at Lyallpur on rice straw, the staple cattle feed in Kangra District (Punjab) with Heifers.

This rice straw (1928 crop) was found deficient in protein which deficiency can be made good by supplementing it with concentrates such as maize grain and *toria* cake and to some extent by green oats when fed with rice straw in the ratio of 1 : 3. One and a half pound to two pounds maize grain or about a pound of *toria* cake when added to rice straw fed *ad lib.* would constitute a maintenance ration for a cow weighing about 500 lbs. (the average weight of a Kangra cow). The introduction of some leguminous crop in the valley has been suggested to supplement the fodders in general which is perhaps the easiest way to meet the protein deficiency at this stage of the economic development of the district when the dietary of the people themselves is poor and their capacity to purchase concentrates for cattle almost *nil*.

Better feeding should precede the introduction of improved breeds in the valley. [P. E. L. & P. L. C.]

**The existence of fowl typhoid in India.** HUGH COOPER and R. N. NAIK. (*Ind. J. Vet. Science and Animal Husbandry* **1**, 99.)

An outbreak of disease in a flock of poultry at Bhowali in the Kumaun hills was reported to this Institute in August 1930 when a dead fowl was forwarded for examination. Deaths took place in this outbreak mainly among adult birds and as single cases occurring over a period of about two months. From the clinical history reported the disease was at first suspected to be Fowl Cholera and the use of serum and vaccine against this disease was advised. Bacteriological examination, however, subsequently showed that the outbreak was due to *Salmonella gallinarum*, Klein.

It is believed that the disease Fowl Typhoid, due to this organism, has not before been reported in India, and a further point of interest lies in the fact that outbreaks of disease in fowls may be wrongly diagnosed and account for failures from the use of serum and vaccine prepared for use against Fowl Cholera.

The disease was transmitted artificially at the laboratory to healthy fowls by the injection of culture and the course of the disease was then studied.

Bacteriologically the organism isolated in this outbreak was indistinguishable from a "type" strain of *B. gallinarum* obtained from the Lister Institute, London.

Since the existence of Fowl Typhoid in India has now been proved, it is a matter of considerable importance to take steps at once to study the extent and distribution of this disease in India.

**Ranikhet disease : A new disease of fowls in India due to a filter-passing virus.** HUGH COOPER. (*Ind. J. Vet. Science and Animal Husbandry* **1**, 107.)

This disease was first recognised in India in 1927. It is an acute, usually non-febrile, contagious and highly infective disease of fowls, caused by a filter-passing virus and characterised by respiratory distress, and high mortality. Reports have frequently been received of heavy mortality occurring amongst the crow population of infected localities. The incubation period in the artificially produced disease is ordinarily from 3 to 5 days, but may be as short as 2 days or delayed until the 6th or 7th, and exceptionally even the 14th day. The duration of recognisable illness in the artificially produced disease is usually extremely short, averaging only 1½ days, but the period may extend to ten days. Ninety-five per cent. of Indian country-bred fowls used in transmission experiments proved to be susceptible to the virus and only ten per cent. of the affected animals survived. Except for the occurrence of petechiae in the submucosa of the proventriculus, *post-mortem* lesions of diagnostic value are almost entirely absent. Emulsion of internal organs stored unpreserved in a refrigerator have been proved to retain their infectivity for periods extending to 169 days. Serum obtained from recovered fowls is protective against the disease, but serum produced from donkeys proved to have no protective value. A few attempts were made to prepare a vaccine suitable for employment against the disease, but they were unsuccessful. The disease has been shown to be immunologically identical by cross-immunity tests with both "Newcastle disease" in England and "Avian pest" in the Philippine Islands.

# NOTES

## TRENCHES FOR SOWING SUGARCANE.

As far back as 1916 Messrs. G. Clarke and Naib Husain published their notes on improved methods of sugarcane cultivation. Their investigations were carried out at the Sugarcane Research Station, Shahjahanpur. It was found out that yield of *rab* and *gur* per acre could be increased by using improved canes and improved methods of cultivation. They started with Ashy Mauritius and J. 33 and now we have got a number of varieties bred at Coimbatore. The improved methods of cane cultivation mainly consist of sowing the sets in trenches and earthing up the plants before the setting in of rains.

These trenches are generally made about the month of November. Surface soil to the depth of 6 inches is dug over and heaped up along the trench on one side of it. The sub-soil is then dug to a depth of 9 inches and left in the trench together. Whatever manure is available is then applied and mixed with it. By the end of February cane is planted in trenches thus prepared.

The writer had to start cane cultivation. The land was under potatoes, which were dug up about the middle of February. It was not possible to use trenches prepared by the ordinary method in vogue: there was no time for the sub-soil to weather by the action of the sun and the wind. There was little hope for the sugar cane plant to flourish in a bed of new undisintegrated sub-soil. The writer thought if the trenches were so made that they were filled with cultivated soil from the surface and the sub-soil dug and heaped up to form ridges, the difficulties mentioned above could be easily surmounted.

After potatoes had been collected, the field was well tilled with a Meston plough and the soil well pressed and pulverised. Then the preparation of trenches was taken in hand. The reader is referred to diagram A B C D (p. 586) which represents the field. The trenching operation began from the side A D. A strip A P Q D, four feet in width, was marked out by means of a string fixed at P Q, the labourers removed all the cultivated soil from A P Q D and heaped it just outside the strip and along P Q. Another string P′ Q′ was fixed at 2 ft. from A D and a trench P′ P and Q′ Q, 2 ft. in breadth and about a foot in depth, was dug out. The sub-soil was heaped up to form a regular ridge A P′ Q′ D with a base of two feet. The bottom of the trench was then dug to the depth of 9 inches. The cultivated soil that had been heaped along P Q was now put in to the trench and it formed the bed for planting sugarcane sets. Having prepared the trench, the operation started from P Q and another trench R′ R and S′ S was made and in this way the entire field was covered with trenches. When the trenches were complete, the dung and

village refuse were spread in them. After mixing manure with the soil, the trenches were thoroughly irrigated. When the land was sufficiently dried, the seed-bed was prepared by digging and the cane was sown in trenches with the *Kudalis* or *Kasis*.

After cultivation and earthing of canes were done in the usual way, I had not sufficient supply of manure; and by the middle of the month of May, I applied ammophos at the rate of one maund per *bigha*. The crop was ready in the month of February next. C. O. 213 was the variety of cane that had been sown, and in spite of the slump in market prices, the gross income yielded by the crop came to Rs. 390 per acre. The area actually planted by me was 22 *biswas*. Some damage had been done by the white ant and but for this the income would have been somewhere in the region of Rs. 450 per acre.

The advantages of this method are :—

(1) That if a petty farmer cannot spare his land for two years to take a single crop of sugarcane and if he has got sufficient quantity of manure, he can plant sugarcane in trenches after taking an early crop of *Rabi* from his land.

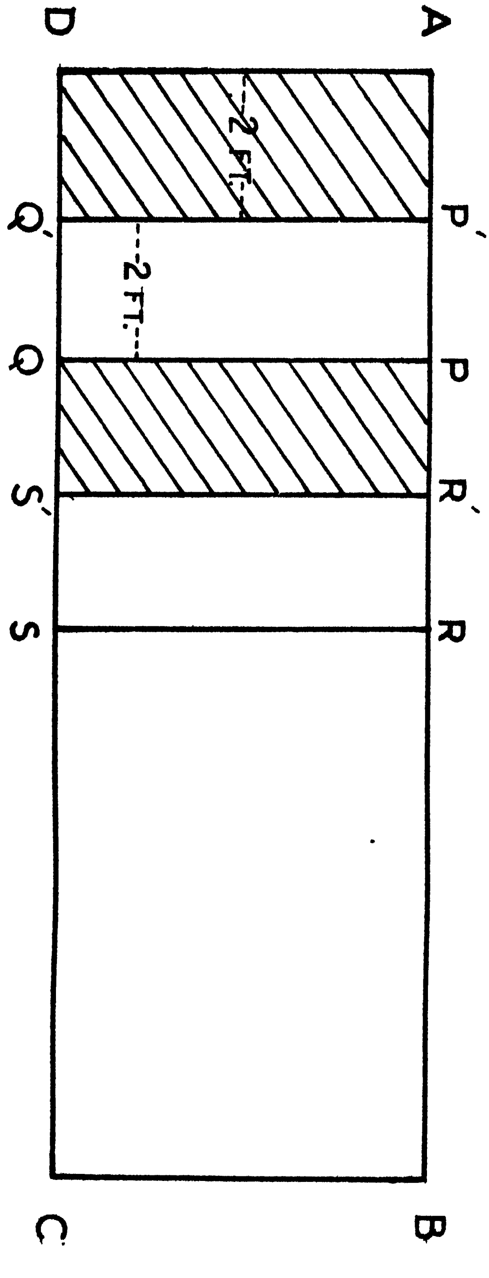
(2) That the early development of the plant takes place in a bed which is formed of well-cultivated soil.

(3) That even if the land has been previously green-manured, the enriched soil would be available to the plant from its very start instead of coming down in small doses with each hoeing when the ridge made by the usual method is progressively felled down (it should be understood that in the usual system of making trenches the richest soil lies at the bottom of the ridge and some 6 inches above the level of the trench).

(4) That in the usual system the seed-bed is formed in the sub-soil which has seen only the mild sun and cold wind of the winter for about $3\frac{1}{2}$ months. While here the sub-soil is completely thrown out to form the ridge which is acted upon by the hot sun and the fierce *loo* (hot winds) of the hot weather.

(5) That so far as the advantages of the new soil to crops grown in subsequent years are concerned, the usual method gives the minimum for the ridge which is mostly formed of surface soil and which when thrown into the trench again forms the surface soil. On the other hand, in this method the ridge is almost completely formed of sub-soil which remains on the surface of the land even after the sugarcane crop has been removed.

There was no opportunity to have a comparative study of the two methods. It has to be left for some future date or for any of the readers who might be interested in it. [RAJ KISHORE SINGH.]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# Plans for the Porto Rico Congress—A Cane Variety Collection—Activities Among the Regional Sections and Technical Committees.

### Exhibits Planned for Porto Rico.

Preliminary arrangements for the San Juan Congress are proceeding apace. In order to add to the interest of the international gathering and make the Congress more instructive, the local committee, in co-operation with the Department of Commerce of Porto Rico, is planning a manufacturers' exhibit of machinery and supplies for sugar estates. A meeting has been called in Porto Rico for the purpose of launching this project. Firms that wish to take part in this exposition are invited to address the Local Secretary of the Society, Mr. Manuel A. del Valle, Central Constancia. Toa Baja, P. R.

### Cane Variety Collection in Porto Rico.

Another important attraction to be offered to the members and guests of the society is the cane variety garden which is now being established in Porto Rico, under the direction of Dr. E. W. Brandes, by the United States Department of Agriculture. Dr. Brandes announced in the February number of "Facts About Sugar" that the resolution adopted by the society at the Soerabaja meeting is thus being carried into effect in the West Indian area. The attention of all the members of the society is called to this article. In order to prevent possible misunderstandings, it should again be emphasized here that the purpose of this collection is to offer an opportunity for botanical study of the original and other important cane varieties, but that it is not to be used as a source of seed cane. All requests for planting material should, as heretofore, be addressed to the experiment stations and similar institutions where the varieties desired have originated or are grown on an extended scale.

### Manuscripts for the Porto Rico Congress.

All the reports and papers to be presented at the San Juan Congress should reach Mr. Manuel A. del Valle, Central Constancia, Toa Baja, Porto Rico, by October 1, 1931, so that there may be sufficient time for preparing preprints to be distributed before or at the opening of the Congress. All the committee chairmen and authors of papers are requested to assist the local secretary by sending in their manuscripts as early as possible.

## MEMBERSHIP AND REGIONAL SECTIONS.

It is very gratifying that we are able to report a total enrolment of 286 paid members at the time of writing. The total membership for the previous three-year period is not known, only the names of members who actually attended the three congresses having been published. The number of attendants at the Honolulu congress, when the society was founded, was 45, at the Havana congress, 159, and at the Soerabaja congress, 144.

At the present time thirteen regional sections have been officially organized. In nine geographical divisions—Cuba, Hawaii, Holland, Natal, Peru, Porto Rico, Queensland, Reunion, and the United States (exclusive of Louisiana)—we have twenty or more members each, while there are smaller sections in Colombia, Egypt, India, and Santo Domingo.

Special mention should be made of the island of Reunion, with a total area of about 2,500 square kilometers, where a complete section of 25 members has been formed through the enthusiastic work of M. Auguste de Villele.

M. Guillaume has accepted the Vice-chairmanship for Indo-China, vacated by the resignation of P. Vieillard, and is now enrolling members there. J. P. Ogilvie has consented to organize a section, as vice-chairman for the United Kingdom. Manual Roxas has found it impossible, on account of his many other engagements, to form a Phillippine section, and H. Atherton Lee has been requested to take over his duties. The Java section is at present being organized by a committee headed by E. C. von Pritzelwitz van der Horst, and with A. van. Leer as secretary. It is confidently expected that the remaining cane regions, notably, Argentina, British West Indies, Japan, Louisiana, and Mauritius, will soon follow the good example of those named above.

## WORK OF TECHNICAL COMMITTEES.

T. S. Venkatraman (India), Chairman of the Committee on Varieties, has added the following technologists to his committee: R. A. Bourne (U. S. A.), G. Bremer (Java), W. E. Cross (Argentina), H. H. Dodds (Natal), H. T. Easterby (Queensland), G. M. Fortun (Cuba), F. A. Lopez Dominguez (Peru), N. B. Mendiola (Philippines), Nand Lall Dutt (India), A. H. Rosenfeld (Louisiana), and D. L. Van Dine (Cuba). The committee will collect data on the characteristics of the seedlings raised from different parents, including wild Saccharums, comprising such characters as vigor of growth, and resistance to various diseases; on the conditions for arrowing and for arrow fertility; on the technique employed in the pollination and in the growing of the seedlings; on the methods of selection and elimination as practised in the different countries. This plan may be extended or altered through suggestions offered by the members of the committee.

R. Fernandez Garcia (Porto Rico) has been appointed acting chairman of the Committee on Cultivation and Field Operations, and Melville T. Cook (Porto Rico), acting chairman of the Committee on Diseases.

The chairman of the Committee on Uniformity in Reporting Factory Data sent out Questionnaire No. 4, on methods of analysis, on December 29, 1930. Questionnaire No. 2, on methods of boiling house control, has been returned by 12 out of a total of 14 committee members to whom it was sent. These replies have been compiled and will be mimeographed for reconsideration by the committee at the San Juan Congress. Questionnaire No. 3, on methods of weighing, measuring and sampling, has so far been sent back by only 6 members, while 8 replies remain outstanding. Replies to all questionnaires, Nos. 2, 3 and 4, must be in the hands of the chairman by July 1, 1931, in order to be considered in the report on the committee to be presented at the San Juan Congress.

C. E. Pemberton (Hawaii), chairman of the Committee on Insect Pests, reports that J. G. Myers (B. W. I.) will contribute to the programme of the congress a paper on the biological control of sugar cane pests in the British West Indies.

### SUGAR ABSTRACTS.

The first number of this new periodical appeared in January, to be followed by monthly issues. Through the initiative of the editor, Dr. O. W. Willcox, it has been possible to include the literature on beet growing, as originally provided in the resolution adopted at the Soerabaja Congress. The new journal will grow in size, quality, and value in exactly the proportion in which each individual author and each technical sugar institution collaborates by sending in abstracts of papers published by them. Every individual who helps in this undertaking will in turn be helped by hundreds of others; this idea of mutual service for the good of all should strongly appeal to everybody interested in the progress of sugar technology. [Dr. F. W. ZERBAN.]

## WOODHOUSE MEMORIAL PRIZE.

In memory of Mr. E. J. Woodhouse, Late Economic Botanist and Principal of Sabour Agricultural College, who was killed in action in France in 1917, a prize in the form of a silver medal and books of a combined value of Rs. 85 will be awarded to the writer of the best essay on a subject of botanical interest to be selected from the list noted below. The length of the essay should not exceed 4,000 words.

The competition is open to graduates of Indian Universities and to Diploma holders and Licentiates of recognised Agricultural Colleges in India who are not more than 30 years of age on the date of submission of their essays.

Papers should be forwarded to the Director of Agriculture, Bihar and Orissa, Patna, before November 1st, 1931.

Failing papers of sufficient merit no award will be made.

G. S. HENDERSON,
*Director of Agriculture, B. & O.*

List of subjects for 1931 prize :

1. The relative value of in-breeding and out-breeding in crop improvement.
2. The problem of Fodder Crops in India.
3. Virus diseases.
4. Symblosis and plant growth.
5. The study of correlations and their economic bearing in the science of plant breeding.
6. The inter relations between vegetative propagation and seed reproduction.

# Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

The Hon'ble Sir Frank Noyce, Kt., C.S.I., C.B.E., I.C.S., Secretary to the Government of India in the Department of Education, Health and Lands, has been granted leave on average pay for four months out of India, with effect from the afternoon of the 2nd July, 1931, and the following appointments have been made, with effect from that date :—

Mr. G. S. Bajpai, C.I.E., C.B.E., I.C.S., Joint Secretary, to officiate as Secretary.

Mr. A. B. Reid, I.C.S., Deputy Secretary, to officiate as Joint Secretary.

Mr. Ram Chandra, M.B.E., I.C.S., Additional Deputy Secretary, to officiate as Deputy Secretary.

His Excellency the Governor-General in Council has been pleased under the provisions contained in rules 1 and 13 of the Rules and Regulations of the Imperial Council of Agricultural Research to appoint the Chief Agricultural Officer, Sind, as a member of the Imperial Council of Agricultural Research and also as a member of its Advisory Board.

The services of Mr. P. H. Rama Reddi, M.A., B.Sc. (Edin.), I.A.S., serving as Deputy Secretary to the Indian Central Cotton Committee, Bombay, have been placed temporarily at the disposal of the Board of Governors, Institute of Plant Industry, Indore, for appointment as officiating Director of the Institute, with effect from the 10th April 1931 until further orders.

In consequence of vacancies caused by the retirement of nominated members with effect from 1st April 1931, the following have been nominated to be members of the Indian Central Cotton Committee, Bombay :—

*By the Government of Madras.*

Mr. H. B. Moore to represent the cotton manufacturing and cotton ginning industry.

Mr. V. C. VELLINGIRI GOUNDER, of Vellaikinar, to represent the cotton growing industry.

*By the Government of the United Provinces.*

Mr. P. B. RICHARDS, Entomologist to Government, to represent the Agricultural Department.

*By the Government of Bombay.*

Rao Bahadur BHIMBHAI RANCHODJI NAIK to represent the cotton growing industry.

*By the Government of Burma.*

Mr. F. D. ODELL, Deputy Director of Agriculture, West Central Circle, Magwe, to represent the Agricultural Department.

*By the Government of the Central Provinces.*

Mr. F. J. PLYMEN, C.I.E., I.A.S., Director of Agriculture, to represent the Central Provinces Agriculture Department.

Mr. Y. G. DESHPANDE, B.A., LL.B., Pleader, Amraoti, to represent the cotton manufacturing industry in the Central Provinces and Berar.

*By the Government of the Punjab.*

CH. ZAFRULLA KHAN, Bar-at-Law, M.L.C., to represent the cotton manufacturing or ginning industry in the Punjab.

In pursuance of clause (xi) of Section 4 of the Indian Cotton Cess Act, 1923 (XIV of 1923), the Governor-General in Council is pleased to appoint the following to be members of the Indian Central Cotton Committee constituted under the said Act:—

Mr. V. RAMNATHA IYER, Cotton Specialist, Coimbatore.

Dr. W. BURNS, I.A.S., Principal, Agricultural College, Poona.

Mr. C. V. SANE, M.Sc. (Wiscon.), Director of Agriculture, Baroda State, has been nominated by the Durbar of the Baroda State to be a member of the Indian Central Cotton Committee to represent that State, *vice* Dr. V. N. Likhite.

Mr. J. H. WALTON, M.A., M.Sc., I.A.S., Imperial Agricultural Bacteriologist, Imperial Institute of Agricultural Research, Pusa, has been granted leave on average pay for 7½ months with effect from the 7th April 1931.

Mr. N. V. JOSHI, First Assistant to the Imperial Agricultural Bacteriologist, Pusa, has been appointed to hold charge of the current duties of the post of Imperial Agricultural Bacteriologist in addition to his own, with effect from the 7th April, 1931, during the absence of Mr. J. H. Walton on leave.

Mr. ARJUN SINGH, L.Ag., First Assistant to the Imperial Agriculturist, has been appointed to hold charge of the current duties of the Imperial Agriculturist, in addition to his own, with effect from the 17th March 1931, until further orders.

Dr. F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S., I.A.S., Imperial Economic Botanist, Imperial Institute of Agricultural Research Pusa, has been granted leave on average pay for 7 months with effect from the afternoon of the 18th March 1931.

Khan Sahib ABDUR RAHMAN KHAN, First Assistant to the Imperial Economic Botanist, has been appointed to hold charge of the current duties of the post of the Imperial Economic Botanist, in addition to his own, with effect from the 18th March, 1931, until further orders.

Mr. H. COOPER, M.R.C.V.S., First Veterinary Research Officer, Imperial Institute of Veterinary Research, Muktesar, has been granted leave on average pay for 8 months, with effect from the 16th June 1931 or any subsequent date.

*Madras.*

Mr. G. R. HILSON, B.Sc., I.A.S., Offg. Director of Agriculture, Madras, has been granted combined leave for one year, four months and 20 days with effect from the 5th May 1931, or the date of relief.

Pending the appointment of a Director of Agriculture, Rao Badadur D. ANANDA RAO, B.Sc., Headquarters Deputy Director of Agriculture, Madras, has been placed in full charge of the duties of the Director of Agriculture, Madras, in addition to his own, with effect from the date on which he took over charge.

Mr. N. S. KULANDAISWAMI PILLAI has been appointed to act as Deputy Director of Agriculture, V Circle, Madras, with effect from the date on which Mr. Govinda Kidavu, Dip. Agri., went on leave preparatory to retirement.

Mr. N. G. CHARLEY, B.E., Research Engineer, Coimbatore, has been granted leave on average pay out of India for three months from the 15th June 1931, or date of relief.

Mr. H.E.R. DUNHILL, Assistant Agricultural Engineer, Coimbatore, has been granted leave on average pay for two months and eight days from 7th August 1931, preparatory to retirement.

*Bombay.*

Mr. M. MOHEY-DEEN, M.R.C.V.S., Assistant Professor, Bombay Veterinary College, has been granted leave on average pay on medical certificate for six months and eight days with effect from 2nd February 1931.

Mr. C. S. PATEL, Cotton Superintendent, Surat, has been appointed Deputy Director of Agriculture, N.C.D., *vice* Rao Sahib K.M. Pawar deceased.

Dr. M. K. PATEL has been appointed to be Assistant Professor of Mycology, Poona Agricultural College, and placed on probation for one year.

*Bengal.*

Babu KALIDAS RAY, Superintendent of Agriculture, has been appointed to act as Live-stock Expert to the Government of Bengal, during the absence on leave of Mr. F. J. Gossip, or until further orders.

Rai Sahib SHARAT CHANDRA PAL has been permitted to resume charge of his duties as Assistant Director, Civil Veterinary Department, Western Range, on expiry of the leave granted to him.

*United Provinces.*

Mr. C. H. PARR, I.A.S., Deputy Director of Agriculture, Cattle-breeding Section, has been granted leave on average pay out of India for six months with effect from May 31, 1931, or subsequent date of availing.

Saiyid Muhammad RAZA HUSAIN, Divisional Superintendent, Cattle-breeding Section to be Temporary Deputy Director of Agriculture in charge of cattle-breeding operations, in the United Provinces Agricultural Service, *vice* Mr. C. H. Parr granted leave.

*Punjab.*

On reversion from the Imperial Institute of Veterinary Research, Muktesar, where he had been deputed to officiate as Director, Mr. W. TAYLOR, M.R.C.V.S., D.V.H., I.V.S., resumed charge of his appointment as Principal, Punjab Veterinary College, Lahore, on the 9th April 1931, relieving Captain U. W. F. Walker, M.C., M.R.C.V.S., I.V.S., who reverted to his substantive appointment as Professor of Surgery at the Punjab Veterinary College, Lahore, with effect from the same date.

On being relieved by Mr. W. Taylor, M.R.C.V.S., D.V.H., I.V.S., LALA DURGA DAS, P.V.S., temporary officer appointed to carry on the duties of the Professor of Medicine during the absence on deputation of Mr. Taylor to Muktesar, reverted to his substantive appointment as Assistant to the Professor of Medicine at the Punjab Veterinary College, Lahore, from the 9th April 1931.

*Burma.*

Mr. M. R. HANDA, M.Sc., has been confirmed in his appointment as Lecturer in Botany, Agricultural College, Mandalay, with effect from the 1st February 1931.

Mr. U. PE THAN, Officiating Deputy Director, Veterinary Services, has been appointed to the Burma Veterinary Service (Class I) with effect from the 4th July 1929.

Mr. J. BHATTACHARJEE, M.R.C.V.S., has been appointed to the Burma Veterinary Service (Class I) with effect from the 4th July 1929.

Mr. A. HAYES, A.M.I.MECH.E., Agricultural Engineer, was posted to Mandalay for training in Land Records and Surveying for one month from the 7th January 1931.

Mr. J. SMITH, M.R.C.V.S., Veterinary Reseach Officer, has been posted to the Agricultural College, Mandalay, for training.

### *Bihar and Orissa.*

Major P. B. RILEY, M.R.C.V.S., I.V.S., Deputy Director, Civil Veterinary Department, who was appointed to officiate as Director, Civil Veterinary Department, Bihar and Orissa, and Veterinary Adviser to Government, has been appointed to be Director, Civil Veterinary Department, Bihar and Orissa, and Veterinary Adviser to Government, on probation for two years with effect from the 24th November 1930.

### *Central Provinces.*

On return from leave granted to him, Rai Sahib GOURI SHANKAR SHRIVASTAVA, Deputy Superintendent, Civil Veterinary Department, has been posted to the Nerbudda Division.

# REVIEW

## THE REPORT ON THE VEGETABLE OIL INDUSTRY OF HYDERABAD STATE.

**(Review of Recently Published Survey Report.)**

*(From a correspondent.)*

In view of the appointment of a Sub-Committee of the Imperial Council of Agricultural Research to study the problems connected with the Vegetable Oil Industry of Greater India, the appearance of this publication showing the results of an enquiry, which has recently been carried out in an important Indian State, is both welcome and timely.

Bulletin No. 1 (New Series) entitled "Report on the Vegetable Oil Industry of Hyderabad State" which has recently been published by order of the Trustees of H. E. H. The Nizam's Industrial Trust Fund, and which has been written by the Officer in charge of Hyderabad State Oil Industry Survey (Mr. A. F. Yuill, A. M. I. Chem. E.) will well repay perusal and careful study by all who are in any way concerned with the enquiry which the Research Council's Sub-Committee are conducting. Copies may be obtained from the Commerce and Industry Department of Hyderabad State at Rs. 3, per copy, or through booksellers.

At the time the Report in question was written the full force of the economic blizzard, which has since devastated Agricultural India, had not been felt, and many of the price figures quoted in the Report are now out of date, but, as pointed out in a foreward by Mr. B. Abdy Collins, C.I.E., I.C.S., Director-General and Secretary, Commerce and Industry Department, the further fall in price, which has occurred since the Report was written, does not in any way affect the conclusions drawn.

### AREAS UNDER CULTIVATION AND CROP YIELDS.

From an agricultural point of view, the most interesting information contained in the Report is that dealing with the varieties of oilseeds cultivated in the area under survey, the actual area under cultivation for each variety, and the yields per acre for each. Information on all these points is given in the Report. In Section I, Chapter 2, will be found a tabular statement giving the acreage and reported yield of each oilseed for each of the five years ending 1928-1929. From this we note that the total acreage in the State under all oilseeds, including cotton, rose from about five and a quarter million acres in 1924-1925 to nearly six and three quarter million acres in 1928-1929; that the greatest increase in acreage shown was

in regard to groundnuts, the acreage under which increased by about 400 per cent. during the five years in question; that next to cotton, castor seed claims the largest average area; and that the average area under this crop (about 600,000 acres) varies little from year to year. The figures relating to reported crop yields given in the tabular statement in question are, as pointed out by the writer of the Report, somewhat unreliable, and these have been duly corrected in the section dealing at length with individual crops.

### CASTOR-SEED CROP—IMPORTANCE OF HYDERABAD SUPPLY.

The chapter in Section II dealing with castor-seed will be found to be of more than general interest. This is due to the fact that Hyderabad State supplies more than half of the castor-seed, which enters into the world commerce, and nearly two-thirds of Greater India's export of this commodity.

Whether an outturn of about 300 lbs. per acre for a crop like castor can be considered to be satisfactory from the cultivator's point of view, is doubtful, but the fact that the acreage shows no sign of falling off would seem to indicate that cultivators in the major areas of production at least have not been able to find any alternate crop which gives better results. Efforts are being made by the Economic Botanist, attached to the Agricultural Department, to improve the crop yield of selected varieties of castor-seeds, and it appears that there is good reason to believe that success in this direction will be achieved.

### LIMITED LOCAL CONSUMPTION OF CASTOR-CAKE.

The information given in the Report as to the limited use to which castor-cake is put in Hyderabad State is disappointing. Considering its high rating by cultivators in other parts of India, it is surprising that in the most important castor-seed growing division, it should be held in so little esteem.

### GROUNDNUTS—EXTRAORDINARY DEVELOPMENT.

Following the lead of Madras and Bombay Presidencies, which had shown considerably increased acreages under this crop in the five years ending 1928-29, the cultivators of the Hyderabad Districts bordering on these Presidencies eagerly took to the cultivation of groundnuts, and in five years the area devoted to this crop in the State increased by nearly 400 per cent., the final acreage figures in the case of Hyderabad State, *viz.*, those of 1928-29 being 650,310 acres, as compared with 3,679,349 acres in Madras Presidency and 1,321,000 acres, in Bombay. These latter figures, however, only indicate increases of about 100 and 280 per cent. during the five years ending 1929, as against an increase of 400 per cent. in the case of Hyderabad.

### DISAPPOINTING CROP YIELDS.

The corrected figures showing the total estimated production of shelled groundnuts during each of the five years in question, indicating as they do a net average crop yield of about 500 lbs. of shelled groundnuts per acre, show how much room there is for improvement, before the results can be brought up to the level of the crop yields, reported by the Bombay Agricultural Department for 1928-29, *viz.*, 21 cwts. of unshelled nuts (equal to about 15 cwts. of shelled nuts) per acre.

### OIL-CONTENTS OF DIFFERENT TYPES.

The information given in the Report relating to the different varieties of groundnuts, cultivated n different parts of the State, make interesting reading, as also does that relating to the individual oil content of such varieties. The superiority in this respect of the small Spanish type, grown in the districts bordering on the Khandesh and Nasik Districts of Bombay Presidency, is most marked, as also is that of a so-called "Ranchi" or "Kanke" variety, possibly a small Japanese type of groundnut, recently introduced by the Agricultural Department.

Comparison of the oil-content figures of Hyderabad groundnuts, of the different varieties, with those obtained for similar varieties elsewhere, indicate that Hyderabad State has nothing to fear from such a comparison.

It is interesting to note the suggestion put forward, and evidently based on the results of careful observation by people long concerned with the groundnut export trade, that in certain cases and under certain conditions of storage, the oil-content of groundnuts can be increased to a certain extent even after harvesting.

### WATERING OF GROUNDNUTS.

Attention is drawn to this practice, which is said to prevail to a greater extent amongst merchants in Madras Presidency, and to some extent in Hyderabad State. It is not suggested that any immediate action should be taken to deal with this undesirable state of affairs, but in case complaints regarding damage due to excessive watering increase, executive action may have to be taken to protect the good name of Indian groundnuts.

### GROUNDNUT-CAKE PROBLEM.

Attention is drawn to that curious phenomenon, the occurrence of which has been noted in all groundnut growing areas, *viz.*, the disinclination of Indian cultivators to use groundnut-cake, especially that prepared by means of modern machinery, for feeding to their cattle. In consequence of this mistaken attitude, a very large proportion of the groundnut-cake so produced has to be exported, and,

while the good demand for it which exists in Europe helps to solve the problem of its immediate disposal, the loss of so much soil fertility cannot be viewed agriculturally with anything like satisfaction. Suggestions for investigation, which might lead to the discovery of new uses for this and other oil-cakes, and to find out whether there is any substantial foundation for the cultivators' dislike, are put forward. The possibility of success in finding out new uses for the cake is indicated by the results of certain experiments, carried out by the writer of the Report in conjunction with the staff of the Government Industrial Laboratory, Hyderabad, whereby a new substitute for milk casein has been produced from the filter press sludge, obtained during the process of groundnut oil-milling. We understand that in some respect, and particularly when it is used for the preparation of insecticidal sprays. this new casein substitute has proved itself to be stronger, and more effective than genuine milk casein.

## Cotton-seed Problems.

There can be few more controversial subjects in agricultural and industrial economics, than that dealing with the possibility of utilising the cotton-seed crop of India industrially.

The Report under consideration provides fresh food for thought in this direction, and points out a method by means of which the problem may possibly be solved. Side by side with his survey of existing conditions in this line, the writer of the Report conducted interesting experiments in regard to cotton-seed defibration, and although finality had not been obtained at the time of the completion of the Report, sufficiently conclusive preliminary results appear to have been secured to warrant the recommendation that, "To suit Hyderabad State conditions the undecorticated, rather than the decorticated, system of oil-milling should be followed, that defibration should, if possible, be practised, and that oil expellers should be used for oil extraction in preference to hydraulically operated machinery". Whether or not this dictum equally applies to all-India conditions, will be for the new Sub-Committee to decide, after having seen the newly designed defibrating machinery described in the Report in actual operation. We understand that the complete results of an extended trial of the new difibrating machine will be available shortly.

## Cotton-seed Production—Export and Local Consumption.

According to the figures given in the Report, the total yearly production of cotton-seed in Hyderabad State averages 280,000 tons, out of which 80,000 tons are obtained as the results of hand-ginning the *kapas* in the interior, and

only about 200,000 tons are turned out by the power-driven ginneries, located along the railway lines. Out of an average production of 280,000 tons, the annual exports of cotton-seed for the five years ending 1928-29 have averaged 94,000 tons, while local consumption, including that used for seed purposes, accounts for the balance, *viz.*, 186,000 tons per year. Nothing is mentioned in the Report about the different varieties of cotton cultivated in Hyderabad State, nor about the very interesting experiment in regard to the creation of an exclusively "Hyderabad Gaorani" territory in Nanded District, which is being closely watched in agricultural circles. The matter, however, is not of great interest from an oil industry point of view as the oil-content of the seed from superior grades of cotton does not appear to be in any way higher than that of the inferior.

### OIL-CAKE DISPOSAL PROBLEMS.

Apart from the interesting technical and economical problems involved, which are fully dealt with in this Report, the chief interest in cotton-seed oil milling, from an agricultural point of view centres around the question of getting the cultivator to utilize the oil-cake for feeding to his cattle in place of cotton-seed. Unless he can be induced to do so, and to preserve and utilize on his land the resulting manure, etc., there is little justification for the encouragement of the industry. In view of the great importance of this question, the very full explanation of the method used in determining the feeding value of different food-stuffs, given by the writer of the Report, is fully justified. The only criticism we have to make of the excellent case which he has made out on behalf of defibred cotton-seed cake is that in assuming that this material will have a feeding value equal only to 80 per cent. of that of cotton seed, he is considerably under-estimating its value. Judging from perusal of more recent comparative figure for the two materials, we believe it will be found that defibred cotton-seed cake will be found to have a feeding value almost equal to that of cotton-seed. A carefully conducted feeding trial of this material is at present being conducted at the Imperial Institute of Animal Husbandry and Dairying at Bangalore, the results of which should be available shortly.

### SESAMUM OR TIL-SEED.

While the acreage under this crop in other parts of India, has shown a more or less marked tendency to contract due to the competition of more profitable crops, and to the reduced demand for the oil, due to the increasing competition of groundnut oil the area under *sesamum* in Hyderabad State keeps remarkably steady, and even shows signs of expansion, in spite of the fact that the yield per acre in this State is amongst the lowest reported. The average acreage devoted to

*sesamum* in Hyderabad State during the five years ending 1928-29, according to figures given in the Report was over 510,000 and the average yield per acre about 140 lbs. Judging from these figures, *sesamun* cultivation does not seem to be a very attractive proposition, and it is surprising that the area under its cultivation should be so steady and apparently capable of further expansion.

### KARDI OR SAFFLOWER SEEDS.

This is another crop which from an agricultural point of view hardly seems to justify its continued cultivation. A yield of 200 lbs. per acre of an oil-seed from which only half as much oil and cake can be obtained, as in the case of groundnuts, seems to indicate the urgent necessity for a crop change, which would enable the cultivator to get a better return for his labour and expenditure.

### OTHER OIL-SEEDS.

None of the other oil-seed crops, dealt with in this Report, appears to be of sufficient importance to justify serious consideration. Even linseed is of minor importance, although both acreage and outturn of this seed in Hyderabad State are equal to about 10 per cent. of the corresponding all-India totals. The absence of any indigenous linseed oil-crushing and boiling industry is noticeable. The absence also of any organization for collecting and crushing *mowrah* seed is surprising, seeing that there exists a latent, if not very active, demand for the oil on the part of the local soap makers.

### DISPOSAL OF OIL-SEED CROPS IN HYDERABAD STATE AND GREATER INDIA.

It is interesting to note just how the oil-seed crops of these two areas are actually disposed of, *i.e.*, what proportion of the total crop in each area is exported and what is utilized in the area itself. From the figures furnished by this Report it can be deduced that, in Hyderabad State, (excluding cotton-seed) about 80 per cent. of the total oil-seed crop of 1928-29 was exported, and above 20 per cent. or about 70,000 tons was utilized locally. Including cotton-seed, about 60 per cent. of the total production was exported, and 40 per cent. utilized locally. For Greater India the corresponding figures would probably be found to be about 20 per cent. exported and 80 per cent. locally utilized (excluding cotton-seed), and including cotton-seed 15 per cent. exported and 85 per cent. utilized in the country. Comparison of these two sets of figures shows how backward Hyderabad State is in regard to manufacturing developments as compared with British India and how much scope exists for improvement in this direction.

### Oil-cakes and their Disposal.

The export of agricultural fertility in the form of oil-cakes has long been objected to by agricultural reformers and proposals have been put forward from time to time for the imposition of an export duty on this commodity, in order to curtail export and enable cultivators to purchase their requirements at lower rates. In this connection, it is interesting to note that it is proposed to abolish the existing duty on oil-cakes exported from Hyderabad State in order to assist the vegetable oil industry, and that notwithstanding the recent unprecedented reduction in the market prices of oilcakes, there is as yet no sign of any increased consumption, either in Hyderabad State or Greater India. As a matter of fact, recent export statistics show that, in spite of the low prices which are being realised for them, the export of oil-cakes from Bombay during the first six months of this year has been 50 per cent. greater than during the corresponding period of last year.

### Oil-cake Export Local Consumption.

In spite of the increased export noted above, the weight of oil-cakes exported from British India is still a minor matter, compared with that retained and utilized. In the Report under consideration, the writer puts the oil-cake export figure for British India at 12½ per cent. of the total production. For Hyderabad State according to the same Report the weight of oil-cakes exported thence is a much higher percentage of the total production. The figures given show that 50 per cent. of the total production or about 20,000 tons a year is exported, and that a similar weight is utilized locally. From an agricultural point of view, however, the object to be aimed at, as far as possible, should be a greater and more economical utilization of oilcakes in the country of origin. Mr. Yuill's report, mainly concerned as it is with industrial rather than agricultural problems, does not offer any very clear indications of what steps should be taken to bring about the desired results. Beyond suggesting that further research should be undertaken in the Government Industrial Laboratory at Hyderabad, to find out new uses for groundnut cake, including development of a process whereby it might be made available for human food purposes and proposals for the encouragement of cake-consuming industries, such as dairying, this part of the Report is not as conclusive as it might have been.

### Selection of Suitable Oil-milling Equipment.

Whatever defects the Report may possess, and specialists in particular lines might be able to point out quite a number, it cannot be said that it fails to give an adequate lead in regard to the selection of the right type of oil-milling appliances, for dealing with the different varieties of oil-seeds met with in Hyderabad State.

Furthermore the advice given is backed up by analytical figures, showing the actual results of analysis of samples obtained as a result of using the different appliances recommended.

CONCLUDING PROPOSALS—RESEARCH—ESTABLISHMENT OF OIL INDUSTRY INSTITUTE, ETC.

The proposals put forward in the concluding chapter of the main Report are interesting and ambitious. In this chapter of the Report, the writer puts forward a carefully reasoned plea for the encouragement and development of research work in connection with the problems of the vegetable oil industry. Another plea put forward is for the establishment of an Oil Industry Institute in Hyderabad, along the lines of the Oil Industry Section of the Harcourt Butler Technological Institute at Cawnpore, for the training of supervisory staff for the industry, and a third is concerned with the provision of facilities for training a better type of mechanic, capable of operating successfully modern oil-mill machinery. With regard to the plea for the prosecution of research, no objection can be raised. The results already achieved at the Government Industrial Laboratory, Hyderabad, under Mr. Yuill's guidance are sufficient justification if any is required. The question as to whether or not Mr. Yuill's proposals for the establishment of an Oil Industry Institute in Hyderabad are justified, is a matter for the State authorities to decide, after considering all the factors of the case, including the all-important financial one, but if the experience gained, as a result of the establishment of the Oil Industry Section of the Harcourt Butler Technological Institute is any guide, it is certain that there will be no lack of human raw material, anxious to avail itself of such facilities as may be offered, if the establishment of an Oil Industry Institute in Hyderabad should become an accomplished fact.

# NEW BOOKS

## On Agriculture and Allied Subjects.

The Culture of the Orange and Allied Fruits. By H. Clerk Powell. (South African Agricultural Series, Vol. 8.) Pp. 355+83 plates. (Johonnesburg: Central News Agency, Ltd., 1931) 21s. net.

Maize in South Africa. By A. R. Saunders. (South African Agricultural Series, Vol. 7.) Pp. 284+72 plates. (Johonnesburg: Central News Agency, Ltd., 1930.) 20*s*. net.

Vegetable Crops. By Homer C. Thompson. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Second Edition. Pp. IX+560. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1931.) 25*s*. net.

A Dictionary of the Flowering Plants and Ferns. By J. C. Willis. (Cambridge Biological Series.) Sixth Edition, revised. Pp. XII+752+LVI. (Cambridge: At the University Press, 1931.) 20*s*. net.

An Introduction to the Study of the South African Grasses: with Notes on their Structure, Distribution and Cultivation, etc. By E. P. Phillips. (South African Agriculture Series, Vol. 6.) Pp. 224+121 plates. (Johonnesburg: Central News Agency, Ltd., 1931.) 25*s*. net.

Flora of the Presidency of Madras. By J. S. Gamble. Published under the authority of the Secretary of State for India in Council. Part 9: Commèlinaceae to Cyperaceae, by C. E. C. Fisher, Pp. ii+1533—1687. (London: Adland and Son, Ltd., 1931.) 6*s*. 5*d*. net.

Bacteriological Control of Milk: A Practical Guide to Media Preparation and Milk Testing. By A. G. House. Pp. vii+59. (Reading: The National Institute for Research in Dairying, 1931.) 3*s*. 6*d*.

The Organisation of Farming. Vol. I, Production. By G. T. Garratt. Pp. xv+163. (Cambridge: Heffer & Co.) 6*s*. net.

Plant Ecology. By W. B. McDougall. Second Edition, thoroughly revised. Pp. 338. (London: Henry Kimpton, 1931.) 14*s*. net.

Social Behaviour in Insects. By A. D. Imms. (Methuen's Monographs on Biological Subjects.) Pp. IX+117. (London: Metheun and Co., Ltd., 1931.) 3*s*. 6*d*. net.

Wild Fruits of the Country side: figured and described. By F. E. Huline. (Nature Library.) Pp. 221. (London: Hutchinson and Co., 1 td., 1931.) 5s. net.

The following publications have been issued by the Imperial Department of Agriculture since our last issue :—

*Memoirs.*

Studies in *Cajanus indicus*, by D. N. Mahta, B.A. (Oxon), F.L.S., and B. B. Dave. (Botanical Series, Vol. XIX, No. 1.) Price Re. 1-14 or 3*s*. 3*d*.

Studies in Indian Pulses (2) Some varieties of Indian Gram (*Cicer arietinum* Linn.), by F. J. F. Shaw, D.Sc., A.R.C.S., F.L.S., and Khan Sahib Abdur Rahman Khan (Botanical Series, Vol. XIX, No. 2). Price Re. 1-12 or 3*s*.

MGIPC—S1—III-1-42—2-10 31—2,000.

# ORIGINAL ARTICLES

## SOME RECENT DEVELOPMENTS IN CONNECTION WITH COTTONSEED DISPOSAL.

### Interesting Experimental work in Hyderabad State.

BY

A. F. YUILL, A.M.I. CHEM. ENG.,

*Late Officer-in-charge, Oil Industry Survey, Hyderabad State.*

In the report regarding the Oil Industry Survey, conducted by the writer for His Exalted Highness The Nizam's Government, a certain amount of information is furnished regarding the introduction of cottonseed defibration, by means of a machine, which was constructed at His Exalted Highness The Nizam's Mint Workshops, Hyderabad, according to the design furnished by the writer, and although experiments in connection with the same were not complete at the time the report was prepared, sufficiently satisfactory results had been obtained to warrant the recommendation that for oil milling purposes, cottonseed should be defibred.

In view of the interest which has been created amongst agricultural officers, and others, interested in this new development, the writer has been requested to furnish this Journal with further information, which might be of interest to their readers.

INITIATION OF FURTHER EXPERIMENTS.

After completing the Oil Industry Survey, for which his services had been retained by the Hyderabad Government, the writer assisted in the completion of the constructional and experimental work connected with the defibrating machine, and at an early stage found that it would be necessary to have the machine run on a commercial scale in a cotton-growing centre, in order to accumulate more definite information regarding the actual commercial utility of the process, as shown by the prices, which users of the various products would be prepared to pay for the same in comparison with the materials which they were using.

BASIS OF EXPERIMENTS.

In the first place it was felt that it was necessary to ascertain what price oil millers in Europe would be prepared to pay for defibred cottonseed as compared with the undefibred. To enable this experiment to be carried out, Messrs. Ralli Brothers came forward with an offer to supply, for such experiments, any quantity

of undefibred cottonseed required, to take away the resulting defibred seed and to ship the same to buyers in Europe at their own risk and expense.

Similarly, the Imperial Dairy Expert offered to arrange for comparative feeding trials at the Imperial Institute of Animal Husbandry and Dairying at Bangalore, using defibred cottonseed cake to replace other items of the standard ration.

Again, several officers of the various Provincial Departments of Agriculture offered to furnish trial lots of different types of the cottonseed, in which they were particularly interested, in order to ascertain the results of defibration on the same, and in certain cases to compare the germinating capacity of defibred seed with that of the original.

The Commerce and Industry Department of Hyderabad State was therefore approached with a proposal that its newly constructed cottonseed defibrating machine should be transferred to Nanded, one of the principal cotton growing centres of Maratwada, for operation on a commercial scale. with a view to obtain definite information along the lines indicated.

Sanction having been obtained, the defibrating machine in question was duly installed on the premises of the Osmanshahi Mills at Nanded during the latter part of March.

The situation selected was not entirely satisfactory, as the machine was erected in an open space, where, during a considerable part of the day, it was exposed to the direct rays of the sun, the effect of which must have been considerable, seeing that the maximum shade temperature at Nanded varied between 114° and 117° during a considerable part of the time the experiment was being carried on.

However, in spite of this and other incidental difficulties, the machine worked satisfactorily, and consistently gave results which were quite up to expectation. The fact that it continued to work satisfactorily for a period of nearly two months in charge only of two coolies is a proof that its general construction had been on sound lines, and that the materials used were more or less satisfactory.

### Mechanical results.

Wear and tear of the machine during the course of the experiment was noticeable but in no way exceptional. The carborundum coating of the inner surfaces was found to have worn about $\frac{1}{16}''$ during the course of the experiment, showing that in all probability the carborundum surfaces of such machines may require to be renewed annually.

*Power requirements and output of machine.*—The power required to drive the demonstration machine though considerable was not found to be excessive. As far as could be judged, with the help of the appliances available, it was estimated

that the maximum requirements were somewhere in the neighbourhood of 8 B. H. P. and the average about 6.

The output of the demonstration machine, which, on account of certain mechanical restrictions, was run considerably below the speed for which it was designed, was found to be at the rate of one bag or about 140 lbs. of undefibred cottonseed per hour. This output, as will be noted, is somewhat low, if the machine is to be used for commercial purposes, and it is evident that it will be necessary to construct machines having a much larger output, and with various modifications which will enable them to work continuously instead of intermittently, as in the case of the present machine.

Arrangements will also have to be made to reduce the frictional resistance of the various parts of the machine, so that the cost of working it can be further reduced. By making use of the information obtained as a result of the present experiment, it should not be difficult to construct a machine complying with the aforementioned requirements, and the manufacture and perfecting of such machines is the next problem awaiting solution at the hands of experimenters in this line. It is estimated that a machine fulfilling the requirements mentioned above, and having an output of not less than 5 cwts. per hour can be constructed, and sold at about Rs. 3,000, and that it would require for its operation not more than 20 B. H. P. per hour.

In the case of the original machine, the necessary draught for carrying off the fibre and dust, was obtained by means of a mechanically driven fan, but, as this arrangement was found to give trouble, a compressed air supply, which was available, was utilised. This was found to give more satisfactory results, and it is possible that this or some similar modification may be incorporated in future machines.

## VARIETIES OF SEED TESTED.

During the course of the experiment, cottonseed of many varieties and in varying quantities was passed through the defibrating machine, and only in one or two cases were the results unsatisfactory. One such case, in which the result did not come up to expectation, was that of Cambodia cottonseed, furnished by the Director of Agriculture, Madras. During the process of defibrating this seed, a certain amount of seed breakage took place, due to the excessive amount of lint adhering to the seed, and to the excessive tenderness of the shell. In this case less than 75 per cent. of defibred seed were recovered, the balance representing fibre, dust and some broken seed. The defibred cottonseed, however, was found to contain upwards of 22 per cent. of oil which is a much higher oil content than is found in any of the local varieties, which are at present fetching much higher prices than Cambodia. Provided, therefore, that certain mechanical difficulties can be successfully overcome, it seems reasonable to suppose that the value of the

Cambodia cotton crop could be considerably increased if all the seed produced was defibred before being offered for sale.

*Punjab-American seed.*—Another type of seed dealt with during the course of the present experiment, and in the case of which results were not entirely satisfactory, was that of "Punjab-American" 289 F. received from the British Cotton Growing Association's Khanewal Estate. This seed which in many ways resembles Cambodia also suffered considerable damage during the defibrating process, and the actual outturn of defibred seed was found to be not more than 70 per cent. of the original weight of seed treated.

These results could no doubt be considerably improved upon, as a result of further practice in dealing with the materials in question, and it is evident that, as far as these two varieties are concerned, there is considerable room for such improvement. As, however, Punjab cultivators totally refuse to use cottonseed of the Punjab-American 289 F. type for feeding to their cattle, and the same has to be used for fuel in the boilers at the ginning factories, it is evident that, in spite of the heavy defibrating loss involved, the defibrating process has distinct possibilities, and may help to popularise the cultivation of this otherwise satisfactory variety of cotton.

*Success obtained with Indian varieties.*—It will be noted that both of the varieties of cottonseed which gave unsatisfactory results, were exotic. Strange to say no such difficulties have been found to occur in connection with the treatment of seeds of "pukha" Indian varieties. Some of these latter can be defibrated more easily than others and with lower defibrating losses, but in general it may be taken for granted that any Indian variety of cottonseed can be treated in the "Hyderabad" type of defibrating machine, with the minimum loss due to seed damage. It may be taken for granted that the actual seed breakage in the case of Indian varieties does not exceed 5 per cent.

### "Verum" and "Banilla" Cottonseed.

40 lbs. of Verum cottonseed No. 262 was received from the Akola (Berar) Government Experimental Farm for defibration. This was effected with a loss of only 3 lbs., 37 lbs. of defibrated seed being returned to the Farm, to be tested for its germinating and other activities. 102 lbs. of Banilla cottonseed was received from the Government Agricultural Station, Jalgaon (Bombay Presidency), for treatment. This was effected with a loss of only 11 lbs., 91 lbs. of defibrated seed being returned to the station in question.

### "Panchmahals" Cottonseed.

A lot of about one maund of Panchmahals cottonseed was received from Derol in that district, and it was defibrated with an apparent loss of about

20 per cent. This seed, which appeared to be of a variety similar to Broach, stood up very well and little or no damage to the seed was noticeable. This was probably due to the fact that such seed has a very thick and hard shell, and that the kernel completely fills the shell instead of being more or less loose as noted in the case of "Cambodia" and Punjab-American.

### "Howri" and "Bani" Varieties.

A bag of Howri type seed from Warora in the Central Provinces was supplied by the Superintending Engineer of the Central India Spinning and Weaving Co., Ld., Nagpur. The orginal weight of the bag was 120 lbs. and the weight of defibred seed returned to him was 96 lbs. showing a loss of approximately 20 per cent. of the original weight. Another lot of 125 lbs. of Bani seed from Umri, in the Nanded District of Hyderabad State, was supplied by the same party, and out of this, 101 lbs. of defibred seed was obtained and returned to the supplier. This also gives a loss of nearly 20 per cent. of the original weight.

Most of the other cottonseeds, treated during the course of the defibrating experiments at Nanded, were of the local "Howri" type, and, provided that the original seed was of normal quality, it was found that the average defibrating loss did not exceed 20 per cent. In the case of seed of very inferior quality or containing a large percentage of dust and seed, which had been broken during the ginning process, or in cases where the percentage of exotic seed was higher than usual, somewhat greater defibrating losses occurred.

### Examination of products.

Analysis figures of original cottonseed of the "Howri" variety, and that of various defibred cottonseed products, as ascertained by the Government Industrial Laboratory, Hyderabad, are given in the subjoined statement.

| Particulars | Original Seed 'Howri' | Defibred Seed | Defibred Cottonseed Cake | Crude Fibre and Dust |
|---|---|---|---|---|
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Moisture | 5·61 | 5·38 | 5·00 | 2·87 |
| Oil | 17·24 | 20·05 | 6·55 | 9·50 |
| Albuminoids | 16·37 | 17·50 | 20·50 | 12·81 |
| Carbohydrates | 34·15 | 38·61 | 45·40 | 29·47 |
| Crude fibre | 20·56 | 15·00 | 18·30 | 27·00 |
| Ash | 6·07 | 3·46 | 4·25 | 17·75 |
| Sand | 1·87 | nil | ·14 | 10·88 |

| | |
|---|---|
| Kernel | 56·87 |
| Shells | 43·13 |

In connection with the figures given above it may be noted that in the case of the experiments to which they refer the defibrating loss amounted to about 20 per cent. and the yields of crude oil and defibred cake to $11\frac{2}{3}$ per cent. and 67 per cent.

The figures for the various materials are illuminating, and give a very fair idea of the effect of defibration and the possibilities which its introduction affords for improving the technique of oil milling, and incidentally for solving many of the agricultural problems connected with the cultivation of the cotton crop. A detailed consideration, therefore, of the figures relating to the various materials should prove both interesting and instructive.

### ORIGINAL UNDEFIBRED SEED.

From the foregoing statement it will be noted that the seed treated was of a more or less average "Howri" quality, the sand content only appearing to be somewhat excessive. The percentage of crude fibre, which includes not only the actual fibre adhering to the seed but also the woody fibre contained in the shell, is more or less normal. Judging from the results obtained, it would appear that the percentage of actual fibre adhering to the seed of "Howri" cottonseed of this type is equal to between 6 to 8 per cent. of the total weight of seed, and that the balance represents woody fibre, of more or less digestibility contained in the shells. In the case of very fibrous cottonseed, such as "Cambodia" and "Punjab-American", the percentage of adhering fibre appears to be about double that of the ordinary Indian varieties. It goes without saying that this adhering fibre has no food value whatever, whereas the woody fibre contained in the shell is probably digestible to a considerable extent. The removal of the adhering fibre is, therefore, justifiable, in that its elimination from the digestive process of ruminants must involve some effort, necessitating the consumption of additional foodstuffs. This adhering fibre also harbours all sorts of impurities in addition to the earthy materials shown by the above analysis. These include the eggs of the various plant parasites, including Red Cotton Bugs, and probably also those of the Pink-Boll Worm and other enemies of the cotton crop. The removal of this adhering fibre therefore is further justified, in the interests of insect destruction and in all probability the complete defibration of all cottonseed, whether intended for export, oil milling, cattle feeding or seed purposes, would prove to be a satisfactory method of getting rid of many of the enemies of cotton and other field crops. The question of the relative germinating capacity of undefibred seed, however, has yet to be ascertained, but, as experiments in this direction are to be carried out on one or two Government Farms during the course of the present season, authoritative information on this subject should be available shortly.

### Defibred cottonseed.

The analytical figures given in the above statement for this product are extremely interesting. In the first place, the considerable increase in the oil content will be of considerable interest to oil millers, as not only is the actual oil content of the seed increased by something like 15 per cent., but the removal of the objectionable adhering fibre renders a greater percentage of the oil extractable. This increase in the percentage of extracted oil should help to make Indian cottonseed more attractive to European oil millers, and help it to compete on more even terms with Egyptian cottonseed, which is still being imported into the United Kingdom in very large quantities, whereas Indian seed has almost disappeared from the European markets. More definite information on this subject will become available, after the consignment of defibred cottonseed, which is being sent to England by Messrs. Ralli Brothers, reaches its destination, and gets into the hands of the oil millers. It will be noted from the figures given above that the crude fibre content of defibred seed is about 5½ per cent. lower than that of the original seed. In view of the fact, however, that the defibred seed represents only about 80 per cent. of the weight of the original seed, it will be evident that the actual percentage of crude fibre removed from the orginal seed must have been about 7 per cent. As the crude fibre removed in this case did not appear to contain any finely divided shell particles, it may be taken for granted that the total amount of fibre, which appears to have been removed from the original sample, represents adhering fibre only. The most remarkable point, which will be noted in connection with the figures given above for defibred seed, is the fact that it contains no sand whatever. It was this remarkable freedom from impurities which led to the suggestion that defibred cottonseed might be used for human food purposes. If all the sand and dirt is removed, and in this respect the Hyderabad defibrating machine appears to be 100 per cent. effective, it may be taken for granted that it must be equally efficient in removing other objectionable materials, including the eggs of parasites.

As mentioned above, the defibred seed represents of an average 80 per cent. of the weight of the original seed, the balance being mainly crude fibre and dust which can have little or no food value, and the removal of this objectionable and useless material and the saving in transport charges, which such removal would effect, appear to be sufficient justification for the introduction of defibration. When, however, it is taken into account that defibred seed occupies only two-thirds of the volume of an equal weight of undefibred, and that the possibility of deterioration during transport and storage are greatly minimised in the case of defibred seed, it is evident that defibration represents a considerable advance in the technique of

cottonseed disposal. The only drawback, if such it can be called, of the wholesale introduction of defibration will be that it will become almost impossible for agricultural officers, responsible for maintaining the purity of the different varieties of cotton, to differentiate between the various seeds, and it is more than probable that, in case defibration becomes a universal practice, it may be necessary in the interest of crop purity to entirely prohibit the importation of cottonseed into all cotton-growing areas, except under special license from the Agricultural Department. Such action on the part of the Agricultural Department would not really involve the cultivators in any hardship, and it would doubtless help to popularise the use of cottonseed cake, prepared from defibred seed, in those districts where cottonseed is preferred for cattle-feeding.

## DEFIBRED COTTONSEED CAKE.

The analytical figures for this product, shown in the foregoing statement, indicate that it is, and must be, an excellent cattle food. Its oil content is just about that recommended by the highest authorities. The most remarkable point brought to light as a result of its analysis is its very high carbohydrate content, which is 33½ per cent. higher than that of the original seed, and nearly two-thirds as much as that of the best grains. In Europe, up to within very recent times, the cost of the albuminoid part of the ration was a matter which required most serious consideration. In India, however, and especially under present day conditions, it will be found that albuminoids are cheaper than carbohydrates, so that the remarkably high carbohydrate content of defibred cottonseed cake is a matter of more than ordinary interest to agriculturists. Taking all the facts into consideration, it will be found that defibred cottonseed must have a feeding value more or less equal to the original cottonseed, in spite of the fact that about 12 per cent. of the oil originally present in the seed has been removed and otherwise utilised. As mentioned elsewhere a feeding trial with this material is being conducted at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, the result of which will doubtless show the advantages of using this pure and easily digestible cake, in preference to the doubtful mixtures which at present are palmed off on unsuspecting cultivators as cottonseed.

## CRUDE FIBRE AND DUST.

The analytical figures relating to the above appear at first sight to be disappointing. Its oil content is higher than is really desirable, seeing that the possibilities of making use of it are few, and that, in case the material is to be used for the manufacture of paper pulp, a large percentage of caustic soda

will be required to convert it into a soap before the cellulosic part of the mixtures can be separated and utilised. A portion of the oil content of the material has doubtless been derived from broken kernels present in the original seed, which during the process of defibration have become reduced to a more or less impalpable powder and carried off along with the fibre, and the gum like material, which lies between the actual shell and the adhering fibre and which in fact appears to hold the adhering fibre on to the shell.

The carbohydrate content of the sample apparently comes to a considerable extent from this gum-like material, and as it is not possible to defibrate the seed completely without removing this gum, its presence in the crude fibre and dust will have to be tolerated.

As regards the crude fibre percentage shown in the analytical figues for this material, this is somewhat lower than was expected, and it is somewhat disappointing on account of the fact that it renders the material less attractive from a paper-making point of view. Whether or not it will be found practicable to effect such a separation of the differrent constituents of the crude fibre and dust, so that the percentage of crude fibre can be sufficiently increased to make it more attractive from a paper-making point of view, remains to be seen, but laboratory-scale experiments in this direction, which are being conducted by the writer, indicate that the possibilities of success will be greater if bio-chemical rathar than chemical methods of treatment are followed. The cost of bio-chemical treatment will also work out much lower than the other. The considerable albuminoid content of the crude fibre and dust suggests possibilities of utilising it in certain cases for manurial purposes. Its nitrogen content is apparently nearly half that of castor cake, and, judging from its physical appearance, it should give excellent results on heavy land, although the fact that it contains such a large quantity of injurious insect eggs may necessitate caution in utilising it, in situations where the results might prove injurious to growing crops. Fortunately, however, it has been found that the crude fibre and dust is an excellent fuel, has a calorific value of about 7000, and can be utilised most economically after suitable humidification in suction gas plants for the generation of power required for defibration and other purposes. It is estimated that, if the whole of the cottonseed crop of India was defibrated before being otherwise utilised, and the resulting crude fibre and dust was properly utilised as fuel in suction gas plants, it would be possible to obtain sufficient power therefrom, not only for defibrating purposes but also for ginning and pressing the entire cotton crop. In view of the fact that the reduction of cotton-ginning costs has become a matter of most serious consideration, it is worthwhile considering whether this cannot be effected by the utilisation of the crude fibre and dust result-

ing from defibrating cottonseed. In any case the saving in rail freights which would be effected by the substitution of this material for coal, and its utilisation on the spot for fuel purposes instead of paying transport charges on it for, in some cases, thousands of miles by land and sea appears to be worth consideration and a more logical proceeding than the present.

The crude fibre and dust can also be burned in the furnace of a steam boiler, but it requires more draught to burn it effectively than does coal.

It will probably therefore be advisable to burn it in admixture with coal, rather than alone, when necessity compels its utilisation in existing steam power plants. Needless to say it will not give as high an efficiency when used in this manner as when used in a suction gas plant. When the crude fibre and dust is utilised for fuel purposes in the manner indicated above, the ash from the same, which according to the analysis given above amounts to about 18 per cent. of the original weight, is obtained in the form of very fine dust, free from any suggestion of clinker, and as it contains something like 7 per cent. of potash and 4 per cent. of phosphoric acid, it is possible that it may find application as a manure particularly on rice lands. As it comes in the form of an absolutely dry powder, and apparently has no tendency to absorb moisture from the atmosphere, its use, in admixture with more hygroscopic salts, is probably to be recommended. It is also an excellent cleaning and polishing material for metals. A minor but nonetheless useful by-product of the utilisation of the crude fibre and dust for fuel purposes in a suction gas plant is that of vegetable tar, which is separated from the gases in the tar-extractor of the plant. It is useful for purposes similar to those for which coal tar is used, and it is of more or less equal value. About two gallons can be obtained from each ton of material treated.

### COTTONSEED OIL.

So far nothing has been mentioned about the crude cottonseed oil which was, in this case, obtained as a result of treating the defibred seed in an oil-expeller. This amounted to about 11⅔ per cent., which result could doubtless have been improved upon if the experiment would have been continued for a longer time, but it is fully equal to what could have been obtained by crushing the undefibred seed by any other known method.

As regards the quality of the oil, a London broker writes as follows :—

> "With reference to your favour of —— we have received the sample of Crude Bombay Cotton Seed Oil, which sample compares very favourably in colour with the usual Hull Makes."

The percentage of acidity in the sample in question as ascertained at the Government Industrial Laboratory, Hyderabad, was under 1·2.

According to the report of the broker in question, there is a considerable market in the United Kingdon for oil of this quality in the crude state, for sale to refiners and soapmakers. Hull is the best port for consignments, followed by London. The present price of oil per ton in Europe is about 3½ times the price of cottonseed.

Crude cottonseed oil can also be refined and used locally for edible purposes in competition with sweet oils like til, Kardy Groundnut, etc., but in view of the fact that there is a surplus production of oilseeds and oils in India at present, it is doubtful if the necessary investment in additional refining plant would be justified. Local utilisation of the cake and export of the crude oil would appear to be a more logical method of dealing with the problem.

## Conclusion.

It may be taken for granted that, with the successful introduction of the 'Hyderabad' cottonseed defibrating machine, the preparation of a whole range of new and interesting cottonseed products and by-products, in addition to those described above, has become possible and a certain amount of publicity work will be necessary to bring the same to the notice of the public. It will also take some time to secure public interest, so that immediate results can scarcely be expected. The commercial success or otherwise of defibration will depend upon the ultimate public response and the strength of their demand for such products. If the purchasing public want cottonseed products of this nature, and are prepared to pay the cost of their preparation, ample supplies will doubtless soon become available. As far as the writer is aware, the 'Hyderabad' cottonseed defibrating machine is the only machine, on the market, capable of effecting the complete defibration of cottonseed. Other so-called defibrating machines are on the market, but as these apparently only remove about 50 per cent. of the adhering fibre, they should be classed as 'Delinters'. and may be ruled out of account in any serious consideration of the defibration problem.

In the meantime, the subject of cottonseed defibration is worthy of consideration by all, who are in any way interested in agricultural problems. There are still many problems connected with the economic utilisation of the products of defibration, which required to be investigated, and the assistance of all who are in a position to help in their solution will be welcomed by the writer, who, having severed his connection with Hyderabad State, is no longer in a position to call upon their well-equipped Industrial Laboratory for the necessary chemical and other assistance.

(To be continued.)

# BREEDING OF DISEASE-RESISTANT CROPS.*

BY

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## INTRODUCTION.

One of the main branches of work in the improvement of the agriculture of a country lies in increasing its agricultural produce. This can be achieved to a remarkable extent by a careful regard of soil management and other cultural methods. But when all the possibilities in this direction have been exhausted, further improvement can be made only by increasing the "potentialities" of the plant. Plant-breeding has done much in increasing such potentialities by producing crops superior to those existing before. One of the factors contributing to such a superiority is the quality of resistance in plants against diseases. It is obvious that disease resistance alone may, in many cases, be responsible for the increased yields, because, when a crop is healthy, there is every hope of its proving superior to one that is prone to disease. Hence breeding for disease resistance should be an important item in all programmes for crop improvement.

## GENERAL CONSIDERATIONS.

A knowledge of prevalance of diseases in plants, their causes and their distribution, as well as some other salient features about them, is prerequisite to a sound understanding of breeding resistant varieties. Hence some space can profitably be devoted to these general considerations before other points connected with the problem of breeding for disease resistance are discussed. Moreover, production of disease-resistant varieties is the last method that man has come upon in the evolutionary sequence, hence a review of what diseases in plants have meant to man, and what the latter has been able to do to prevent their severity, will help a plant-breeder a great deal to have an intelligent grasp of the problems.

*Universality of plant diseases.*—The first point of importance in this connection is the universality of plant diseases. Perhaps no plant species, whether cultivated or wild, is free from diseases. There are variations in the intensity of disease from which the different species suffer. Even within a species it is possible to separate

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* Woodhouse Memorial Prize Essay (1930).

out varieties which may be classed as resistant or susceptible to a particular disease. But the existence of a variety immune to all the diseases is very unlikely, if not impossible.

*Causes of disease.*—The disease is due either to interference in the fulfilment of plant's requirements (physiological), or to the attack of some pest, fungal or insect (parasitic), or to the action of what is known as the " virus ". The virus diseases have not been traced to any causative organism. But as they are of the nature of infectious diseases, as proved by injection experiments, it is supposed that they are due to micro-organisms too small to be detected by the microscope.

*Man and plant diseases.*—Further, the knowledge of diseases in crop plants is of great antiquity. Ever since man began to till the soil—even before that—he has been conscious of diseases. Many ancient writings deal with accounts of such diseases. With an obstinacy hard to understand, man used to consider the diseases as visitations of Providence. No rational control methods were devised because the cause was not known. It was only when De Bary in 1853 definitely established facts about parasitism in fungi that new impetus to researches on crop diseases was given, and great strides in the right direction made.

With the cultivation of crops man unwittingly helped the pests also by favouring their perpetuation and dissemination. By growing the crop for his own use under conditions which differ from those found in the wild state, man has not only weakened the resistance of plants to some of the adverse conditions but also has increased the chances for the spread of the disease. It is inconceivable to picture rust epidemics in wheat had the latter been allowed to grow only in the form of isolated individuals as in the wild state.

*Plant interchange and disease resistance.*—As in any other branch of civilization, improvement in agriculture has also involved interchanges of crops from one place to another. If these interchanges had been done with more foresight and under the best of knowledge in possession of man, much harm to agriculture would have been prevented. This knowledge has to do with the effect of change of location not only on the physiological adaptation of the crop to the new conditions but also on its relation to its parasites. When a crop has been grown for a long time in a certain locality, it is likely to evolve certain strains resistant to the adverse conditions prevailing in that locality. These strains are, therefore, in a sort of equilibrium with the elements of nature and are, on this account, best adapted to their native places. Introduction of these to new places is likely to disturb this equilibrium, and maladies may appear, which may be caused by the plant not meeting its full requirements as regards soil, moisture, temperature, etc., or by its

encountering parasites to which it is susceptible. The converse of the latter may also occur, and the parasite may spread with its host to a related susceptible host in another country. Such situations can be met by developing new varieties by hybridization with resistant forms from abroad if suitable forms are not available locally.

### PREVENTION OF DISEASES.

I. *By control measures.*—So far we have been considering the prevalance of plant diseases and how far man has been responsible for their spread. Attention may now be turned to what has been done to protect the crops from diseases. While investigations into the causes of diseases were actively going on and the causative organisms described and classified, very little was being done to devise control and reduce the devastations caused by diseases. It was only when Kuhn advocated the practice of seed disinfection by copper sulphate, and Millardet in 1878 discovered the Bordeaux mixture for spraying, that the ravages of some of the pests were reduced. Such methods of control had difficulty in finding favour with the cultivator. For, besides imposing an annual tax on the cultivator in the form of costs for the fungicides and their spraying, they have not been much encouraged by the governments, although people in support of them would often cite the example of legislations for plant disease control in France, U. S. A. and other states. Though control measures occupy quite an important place in the field of agricultural operations, they are not always the best. They, for example, provide little safety against many root diseases and against virus diseases (such as the sugarcane mosaic). In the former case, even the incorporation of the fungicides into the soil is not of much avail, as that might, besides killing the parasite, annihilate other soil inhabitants, which might otherwise prove useful in maintaining soil fertility by their micro-organic activities. It is true that the ravages in such cases can be reduced considerably by proper rotation and clean cultivation, but it is not always possible to do that. Especially in a country like India, where a system of small holdings prevails, it is difficult to have a rotation which will allow crops to evade soil parasites. The farmer cannot afford to have such a rotation. Moreover, the crop of a careless and ignorant cultivator will be a great source of infection (if it is diseased) to the surrounding crops of his neighbours, whose efforts towards a proper rotation will, therefore, be useless. In such cases disease-resistant varieties are the only hopes of the cultivator.

II. *By breeding disease-resistant varieties.*—From the above facts the role of resistant varieties in agricultural economy will be evident. Their use was first suggested by Knight in 1815. Prevention is always better than cure—and that is saying a great deal in favour of the resistant varieties. It is apparent that their

use eliminates the necessity of other control methods, and is on this account the most economical of protective measures. This method is becoming increasingly popular, and the good results it has yielded with all sorts of crops may be one of the reasons of its popularity.

### Plant disease a heavy tax.

At this step it may be pertinent to emphasize the importance of preventing diseases in plants, or at least mitigating the havoc caused by them, before the method of breeding for disease resistance is explained. Russel has estimated that Great Britain suffers a loss of not less than £15,000,000 to £20,000,000 a year by diseases caused by plant pests [Martin, 1928], and Butler [1906], making a modest computation, claims for the wheat rusts a damage of four crores of rupees annually in India.

### Mendelism and disease resistance.

The stimulus brought into the field of the study of genetics by the discovery of Mendel's memorable results on hybridization in peas raised the work of breeding to a rational and systematic basis, and when the study of heredity was based on the idea of segregation and re-combination of hereditary units, attention was directed towards the phenomenon of disease resistance in order to discover whether this property also behaved like other characters in heredity. Work on these lines established the fact that in most cases it is a property which follows the Mendelian laws of heredity, sometimes resistance being dominant and sometimes recessive, and that, like other characters, it was possible to 'fix' the resistance in a variety.

### Breeding disease-resistant plants.

Breeding of disease-resistant plants is of recent origin, although ideas about it had been formulating in the minds of some much earlier. During the last few years hybridization has been coming more and more into prominence. One reason is that the production of disease-resistant plants is not very difficult. Such plants exist everywhere in Nature, and our duty is to discover them. Like any other easily recognised morphological character, plants show variation in disease resistance as well. Hence the prime necessity consists in our ability to detect disease-resistant plants rather than in their existence in Nature. When a suitable variety possessing resistance has been found, it should be used as one of the parents to cross with other commercial varieties.

As disease resistance behaves in general like other morphological characters, breeding for resistance does not require any special mode of procedure. The breeder should, however, be familiar with the cause of the disease, and, if it is

parasitic, with the life-history of the parasite, especially, its mode of infection. Then the populations of the various generations should be subjected to ample infection and inheritance for resistance studied.

Numerous breeding experiments for disease resistance have been made in various crops, but as none has engaged greater attention than the cereal rusts, it will be best to describe the results of some of these, and to view them in order to discover the main problems that would confront one working on the lines described in the experiments, and to gauge the possibilities of success in the desired direction.

### BREEDING OF WHEATS RESISTANT TO RUST.

*Physiologic specialization in* Puccinia graminis tritici.—Of first importance among the wheat rusts is the black stem rust, caused by *Puccinia graminis tritici* Erik. and Henn. Numerous crosses were made formerly between the different varieties of wheat in order to produce a wheat resistant to this fungus, but as little was known about the inheritance of disease resistance, no marked success was attained. Moreover, resistance was found to vary from place to place, so that a belief in the instability in resistance became prevalent, till the useful work of Stakman [1922] and others showed that the fungus did not exist in one single form, but in several biologic forms, all showing variations as regards virulence towards a particular host variety. This placed the hybridization experiments on a more systematic basis, and to this is due the existence of several rust-resistant commercial wheat varieties today. Sixty-two biologic forms of *P. graminis tritici* are recognized today. Now a variety should be resistant to a great number of these forms before it can be recommended for the field. With such a huge number of biologic forms, breeding of a variety of wheat that would be resistant to all of them would become a remotest possibility if each different form had its own specific reaction towards a particular host variety. But as the reaction of a wheat variety towards a number of biologic forms of the rust may be controlled by a single factor, for the practical purposes of the breeder they can be considered as one. For example, in Kanred wheat the resistance towards eleven of these forms is governed by one factor only. Hence all these eleven forms can be considered as one so far as the Kanred wheat is concerned. This would, therefore, bring the creation of resistant varieties within more encouraging limits.

Some results achieved in other countries may here be described. In order to transmit the immunity of Kanred (a winter wheat produced at the Kansas Experiment Station) to Marquis (a spring wheat), Aamodt [1923] crossed these two varieties. The $F_2$ generation was grown in the field under an artificial epidemic produced by spraying the seedlings with uredospores of several different biologic forms.

The result was that the population showed as great a susceptibility as the susceptible parent itself. This was due to the masking of segregation for resistance and susceptibility on account of the action of the biologic forms to some of which Marquis was susceptible and to the others the Kanred. Hence, under a general epidemic, it is impossible to find out how segregation is going on as regards a particular form. This can be ascertained only by separately infecting the population under controlled conditions with single known forms. Following this procedure, Aamodt found that the hybrids were either resistant or susceptible, no intermediate forms appearing. The susceptible forms were eliminated and the selections for the desired characters made in the field with the various $F_3$ families. The segregation for resistance and susceptibility towards a particular biologic form was found to be very simple. It was moreover found that resistance and susceptibility to several forms may be carried either in a single genetic factor, or in different factors linked in the process of segregation. Numerous $F_3$ selections were obtained which combined the spring characters of Marquis with resistance to all the biologic forms from which Kanred was also immune. This further emphasizes the fact that very desirable characters can be combined in a variety.

The following pedigree of one of the crosses by Aamodt [1927] will show the extent of effort resorted to in order to synthetically produce a variety with recombinations of rust resistance :

1. Marquis }
2. Iumillo } 5. Marquillo . . }

Marquis }
3. Kanred } 6. Hybrid 11 17, 40 . } 8. First double cross . }

Marquis }
4. Vernal } 7. Hybrid 1, 44 . . . . . . } $F_1$ Cross.

Thus, here, eight different varieties have taken part in the scheme.

Hayes and Aamodt [1923] have also carried out work on these lines. They crossed Kota and Marquis wheats and tried to find out whether it was possible to produce a variety resistant to two biologic forms which reacted reciprocally with the two parents. The two biologic forms of rust were designated as Forms XIX and XXVII. They found that out of a total of 372 $F_3$ families three proved to be immune to Form XXVII and resistant to Form XIX, and four families were

resistant to both. From these facts they are justified in stating that "from the standpoint of genetics the facts give reason for the belief that a wheat variety can be produced which will be resistant to all the biologic forms of rust".

In this connection it may be mentioned that experiments as those described above may open up interesting fields of genetic inquiry, and unless the breeder has a sound knowledge of theory, practical results may be long in coming, or may not come at all. Questions such as the following may crop up—How many pairs of factors are involved for resistance or susceptibility? Whether these factors are linked with factors for other agronomic characters or not? Does any correlation exist between the characters concerned? Is it possible to analyse the results by such correlations (if any exist)? — and so on. The breeder should be well equipped intellectually to answer such questions.

### SOME OBSTACLES.

Above has been mentioned the difficulty encountered in breeding for disease resistance caused by the existence of the parasites in several physiologic forms. Besides complicating breeding work, this specialization has resulted in making the problem of breeding for resistance local. The discovery of different biologic forms has, however, helped in explaining some of the aberrant results in breeding. Thus the strain of Hussar wheat produced by Leighty was resistant to smut in America but when grown in Germany it was found to be quite susceptible [Leighty, 1927]. The host variety was not responsible for this apparent freak but the fungus, the German form being different from the American. Similarly, if the Indian Kathia wheat of Cawnpore has proved resistant to orange rust (*Puccinia triticina*) in the United States [Butler, 1906], it is perhaps because this wheat has not yet had the misfortune to come across rust forms suited to it.

But the trouble does not end here. A worse feature of the situation is caused by the fact that new physiologic forms of the fungus may be created from time to time. The two important working agencies in this direction are (*a*) hybridization and (*b*) mutation.

*Hybridization.*—Hybridization in fungi is quite common. It takes place either by the union of *plus* and *minus* strains, or by the fusion of anastomosing hyphæ. The former method was first discovered by Blakeslee in *Mucor*. Later, other workers found the presence of sexual strains in other fungi. More recent still is the important work of Craigie [1927] who has discovered heterothallism in rust fungi. The discovery has cleared away all frail hypotheses and guesses connected with the role of pycnidia (spermatia) in rust fungi, and removed all obscurity connected with the life-cycle of these fungi, especially *Puccinia graminis tritici*. The possibi-

ATE XXXVIII.

**Fig. 1.** Photograph of Petri Dish with a culture of *Helmintl osporium nodulcsum* Berk et Curt throwing out mutan (Saltanto)in the form of sectors. Three sectors have appeared, two darker in colour than the parent and one lighter.

**Fig 2.** Linseed cultures at Pusa. Some of these have been selected for their resistance to the flax wilt caused by *Fusarium Lini.*

lity of the production of new forms by fusion of cells in pycnidia has been experimentally demonstrated by Stakman and others [1930] with the help of the technique evolved by Craigie, and very interesting results are being found.

Hybridization in fungi may take place without the intervention of the sexual stage, *viz.*, by the fusion of hyphal cells. Stevens [1922], Drechsler [1923] and Christensen [1926] have observed such fusions in *Helminthosporium*. Tisdale even attributed the sudden susceptibility to smut in the case of milo (which was not previously known to be attacked by the fungus to such a fusion between two species of the fungus (viz., *Sphacelotheca Sorghi* and *S. cruenta*), and the consequent production of the highly pathogenic form [Leighty, 1927].

*Mutation.*—Mutations are quite common in fungi, and frequently occur in culture media. Sometimes they are very numerous and are widely different from the original fungus. They arise as variations from parts of mycelium and appear generally in the form of sectors when the fungus is grown in Petri dishes (Plate XXXVIII, fig. 1). Several investigators have succeeded in inducing mutation by environmental changes. What is of great importance in these mutations is that, besides differing in cultural characters from their parental forms, they may even differ in virulence. Such a mutation in virulence may be quite common in Nature. This may limit the resistance of a resistant variety only to a limited space of time, which may become a matter of chance. The physiologic forms of different fungi may behave differently as regards mutation. While there is evidence to show that the physiologic forms of rust do not mutate commonly [Stakman *et al*, 1918, 1, 2], those of other fungi may mutate quite readily [Christensen, 1926 ; Stevens, 1922].

*Mature plant resistance.*—Another stumbling block in the way of production of resistant wheat varieties is the phenomenon known as 'mature plant resistance' recently observed at the Minnesota Experiment Station [Goulden, 1929]. It was observed that several varieties of wheat were susceptible to the infection in the seedling stage but resistant at the time of heading. It is clear, therefore, that observations for rust resistance should not be confined to the seedling plants as has been done hitherto but continued up to the mature stage. This peculiarity of mature plant resistance may cause segregation in the field to differ from segregation in the seedlings, and this would upset experiments in which varieties possessing this character are used for crossing. Yet another difficulty is that mature plant resistance has been found to be associated with other undesirable characters. It, therefore, gives rise to the question whether the linkage in such cases is perfect, and whether it is possible to separate the two characters. Only experiments would reveal the possibilities. Whether this mature resistance is possessed by other groups of plants remains to be investigated. It is quite likely, that the

phenomenon is universal, in which case breeding with other crops will also involve the same difficulties as appear in wheat.

Yet another obstacle is that caused by the much too common incompatibility exhibited by wild forms when crossed with cultivated forms. The former, for reason of their hardy and resistant characters, will always be sought by the plant-breeder, but as they stand apart from cultivated forms in taxonomic classification in many cases, a sort of limit is imposed upon their crossability with the other. Cytological investigations have sought to explain the infertility on the basis of chromosome numbers, but there seem to be other determining factors also. Besides this drawback, wild forms have often been found to impart undesirable qualities to the cultivated forms. Sometimes resistance is strongly linked with such qualities, in which case resistance will be dearly bought.

A vast amount of literature is available on work done on rust and smut resistance in wheat and other cereals. It is not possible to mention them here, but they do not differ in any essential points from the experiments described above. While a procedure as that described for wheat rusts is sufficient to indicate the general lines on which such work should be carried out, different crops may require different treatments, and the intelligence of the breeder should be ready to evolve suitable methods.

### SELECTION.

The emphasis given to hybridization in the above paragraphs should not lead one to suppose that disease-resistant varieties can be produced only that way, *i.e.*, by the synthetic incorporation of useful qualities in a particular variety. Selection is also a very efficient means of breeding resistant plants. It has given useful results even in the hands of farmers, unacquainted with the technicalities of the science of plant-breeding. The selection should be started with resistant individuals. The disease-causing organism should be supplied with ideal conditions in order to cause maximum harm to the strains to be tested, and selection of promising plants should be continued year after year. Ample chances for infection should be given, otherwise a really susceptible variety may give false indications of being resistant. Some of the improved varieties of cotton have been produced in this way by the United States Department of Agriculture.

*Wilt resistance in flax.*—Tisdale [1917, 2] has experimented with flax wilt (caused by *Fusarium Lini*) on these lines. His work shows that the resistance is conditioned by multiple factors, hence the crop can be improved by long-continued selection for wilt resistance. The resistance does not develop due to a result of the constant association of the host and the parasite (as once believed), but is due to isolation of resistant strains from susceptible ones.

An interesting fact discovered in this connection is the relation that has been observed by Tisdale [1917, 1] to exist between the temperature and the incidence of wilt. High temperature induces wilt even in resistant strains. Low temperature likewise inhibits wilt to a certain extent. As early-sown crop is less subjected to high temperatures in the seedling stage than that sown late, the part played by time of sowing in giving indications of resistance or susceptibility should be kept in mind, otherwise the results are likely to be vitiated.

### Some achievements.

The difficulties mentioned above are not small; yet the results in the past have been very encouraging. They show that the production of disease-resistant varieties is quite practicable. Among the achievements, Biffen's [1926] work on resistance in wheats to yellow rust, Orton's [1908] production of wilt-resistant, edible water melon, and the creation of Kanred and Hope wheats are of outstanding merit. Wilt in flax and cotton has often proved the limiting factor in the cultivation of these crops. Their cultivation with assurance has been made possible by breeding of resistant varieties by the North Dakota and Minnesota Experimental Stations in the United States. Cabbage yellows (caused by *Fusarium Conglutinans*) has similarly been controlled by the use of resistant varieties selected at Wisconsin.

Even with the small amount of work done on disease resistance in India, promising results have been obtained in some crops. Thus one of the Kumpta cottons of Bombay has a high wilt resistance. Some sugarcane varieties bred at Coimbatore are very resistant to diseases. A jute variety, resistant to the very common chlorosis found in this plant, has been obtained in Bengal. Some of the wheats bred at the Imperial Institute of Agricultural Research, Pusa, are remarkable for their high degree of rust resistance. A wilt-resistant variety of gram has been selected, and it can be grown in disease-infested fields of Burma, which had come to be known as the "graveyard of gram". At Pusa a pure-line type of pigeon pea resistant to wilt has been isolated [Review of Agricultural Operations in India, 1926-27]. Here also a heavy-yielding type of barley (called Barley Type 21) has been produced which is remarkably resistant to the attacks of *Helminthosporium sativum* [Bose, 1931]. Perhaps the heavy-yielding capacity in this case is to some extent due to disease resistance. Similar remarks apply to some linseed varieties bred at Pusa (Plate XXXVIII, fig 2).

### Breeding with reference to different crops.

The most important breeding work for disease resistance has been done with the cereals. As they are annuals the problem is greatly simplified, but with perennials the problem is more difficult, especially with fruit trees, where the great amount of

time required for studying the various generations greatly limits the scope for work. Still results of great importance should be looked forward to in the future with fruit trees, as they constitute man's one of the most cherished possessions.

### NATURE OF DISEASE RESISTANCE.

The question why one variety of a certain crop is susceptible and another resistant to a particular disease occurs naturally to one trying to secure disease resistance. Is it due to morphological or physiological causes? What is, in other words, the *nature* of disease resistance? It is evident that a knowledge of the factors governing resistance will prove useful in forming a basis from which to view comprehensively the experiments for resistance. The problem is, however, an immense field, and a great deal of work has been done in this connection. The results obtained by various workers are diverse, and it seems that the nature of disease resistance, while very obscure in some cases, can be definitely ascribed to some morphological or physiological features of the hosts in others. For example, resistance may be governed by the presence of hairs or waxy coating on the epidermis of the host; the formation of cork or some toxic substances by the host after the penetration has occurred; the acidity of the cell sap; stomatal movement; or by any modification of the host tissues; or by their hypersensitiveness, bringing about the isolation of the fungus and thus killing it. While a great number of such cases can be reviewed, there are instances where no such factor is accountable for resistance, and in such cases resistance must be entirely bound up with the protoplasm.

The nature of disease resistance is thus in many cases obscure and very difficult to find out, hence, though facts throwing light on it may be very interesting and important from a purely scientific point of view, for all practical purposes it should not deter one from one's work. One should try to find out if resistance is correlated with any easily recognizable morphological character, and if there is any such correlation, with its help one can proceed with the work, without probing into the mysteries of the nature of disease resistance.

### DISEASE RESISTANCE AGAINST OTHER AGENCIES.

This essay has dealt mostly with disease resistance in plants against fungi. But the conditions and methods can be applied to insects as well. In the case of physiological diseases the basis of disease resistance should be sought for in a better adaption of the varieties to a particular set of soil and climatic conditions.

### A WORD OF CAUTION.

Disease resistance is an elastic term. A great amount of modification can be induced in disease resistance by changes in environmental conditions. Disease

may appear in spite of the resistant variety. That a great deal of relation exists between the host, parasite and the external conditions can be fully appreciated by the perusal of the work done by Jones [1926] and others in Wisconsin. Especially should this relationship be kept in mind while conducting the experiment. Greatly favourable conditions may considerably increase the susceptibility and obliterate the factors for resistance. Similarly, if the variety under trial is not rigorously subjected to infection, the result will be a false appearance of resistance in really susceptible strains.

## SUMMARY AND CONCLUSION.

From the above it is apparent that the production of resistant varieties is an important means of improving the agricultural status of a country. It may be stated that resistance is a quality which follows inheritance along Mendelian lines, and that advantage can be taken of this quality for producing disease-resistant forms by hybridization or selection. The work is, however, complicated by the existence of the pathogenes in various physiologic forms which, besides differing in pathogenic capacities, may give rise to new forms by hybridization and mutation. This has resulted in many cases in making the problem of breeding for resistance local, and has also limited the time during which a bred variety may be resistant. But as it is possible by hybridization to combine the resistance against several forms in a particular commercial variety, and as new forms may take considerable time to appear the disadvantages under which a breeder has to work may be amply repaid by the results obtained.

In this connection it may be mentioned that for a successful issue in breeding for disease resistance is required the co-operation of a number of workers. Disease resistance is as much concerned with the host as with the pathogene. Hence the knowledge of the one is as much essential as the knowledge of the other. The plant-breeder will try to know all about his varieties, their genetic constitution, and the number of pure lines in which they exist, and so on, without, in a great number of cases, considering whether the fungus, whose effect he is studying, is a single pure line or a complex of various strains. He will most likely consider it a single physiologic entity. Hence, alone he is somewhat unequal to the task of breeding resistant varieties intelligently. The same can be said about a pathologist, as his acquaintance with Mendelism is apt to be sparse on account of the nature of the problems he has usually to tackle. Hence the necessity of the co-operation of a geneticist and a pathologist in disease resistance studies. A physiologist should also prove of use, but an ideal research worker would be one who combined all these branches of knowledge within himself. This is an age of intensive specialization in all branches of studies, hence such a union of qualifications in a single individual is

somewhat rare. This is perhaps the great reason why much work in breeding disease-resistant varieties has not been done in so many parts of the world. Perhaps the most valuable work has been done at the Minnesota Agricultural Experiment Station in the United States. A dozen years of work have produced very valuable results, and there is no reason why other countries should not take a lead in this direction.

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# NOTE ON A SOWING DATE EXPERIMENT WITH PUNJAB-AMERICAN COTTONS AT LYALLPUR IN 1930.

BY

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WITH

## A STATISTICAL NOTE.

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The results of Sowing Date Experiment with Punjab-American Cottons for the years 1926-29 have already been published [Trought. 1930]. The present note deals with the data obtained during 1930. As these results apparently differ from the results already published, no apology is needed for their publication.

The lay-out of the 1930 experiment was designed to permit of the use of Fishers' Analysis of Variance in the statistical examination of results and was decided upon in consultation with Bh. Balmokand, Assistant Professor of Physics, Punjab Agricultural College, Lyallpur.

The two types of cotton used were 4 F and "Early Strain". The plan of sowing was as shown in Fig. I (page 635). The area of each bed was 0·023 acres. The actual yield in lbs. of seed cotton of individual beds is also shown in Fig. I and the yields in maunds per acre are shown in Table I.

The dates of sowing were as follows :—

1st sowing—24th March.
2nd sowing—1st May.
3rd sowing—9th June.

When compared with the results and the recommendations already published for the 4 F variety only, the results in Table I superficially completely contradict the

earlier results. But on examination, this apparent contradiction can be explained satisfactorily, and supports the earlier recommendations.

The probable reasons underlying the advantages gained by later sowing of 4 F were discussed and are repeated here briefly as follows :—

(1) The environmental conditions in May and early June can be so severe as to cause serious detriment to the plant's later development. By sowing in June this severe period is avoided.

(2) There is usually a gradual amelioration of climatic conditions (lower temperatures and higher humidities) at Lyallpur from about the middle of June due to the commencement of the Monsoon in other parts of the Province. Thus the June-sown cottons do not suffer the severe checks to development which the earlier-sown cottons would be expected to suffer.

(3) The June-sown cotton flowers later and thus partially or completely avoids the period of non-dehiscence of anthers. This is of distinct advantage to the plant.

(4) The majority of small zemindars sow their cotton after wheat, and by sowing late, time is available for preparation of the land before sowing and also, owing to small size of plants during July and early August, inter-cultivation can be more easily undertaken during the rainy period.

(5) The late-sown cotton has a greater rate of growth and an increased flower and boll production.

For these reasons a sowing date later than what is at present accepted as the normal was recommended, and it was suggested that early June should be considered as the optimum time for sowing cotton.

If the 1930 crop season be considered, it is found that the severity of climate during May, the deleterious effects of which the later sowings are expected to avoid, was almost totally absent. Both the maximum and minimum temperatures were below that of 1929. The absolute maximum temperature was 109·6 ° F. The relative humidity was, however, the same as in 1929. The rainfall during this month and the number of rainy days was above normal, while there were no dust-storms at all. In fact the whole cotton season of 1930 was much milder than that of 1929. This fact may be reflected in the considerably greater percentage of anther dehiscence which occurred in July and August 1930 compared with the 1929 percentage for the same months.

Later on during the 1930 season, White Fly and Jassids (*Empoasca devastans*) attacked the crop. The attack of Jassids was abnormally severe and this adversely affected the later sowings more than the earlier sowings.

The conditions therefore (which must be considered as normal conditions) under which later sowings are advisable being absent during 1930, the crop's response to the variable under examination, namely, the date of sowing, naturally differed. The experiment, however, shows that the reasons underlying the recommendations for later sowings are probably correct and that later sowings could be safely undertaken in normal years. Abnormally severe years or abnormally mild years as regards climate will always upset the results of normal agricultural practice and this must be expected. The normal practice of early May sowing in an abnormally severe year results in failure due to bad boll opening, whereas the observations have shown that in these abnormal years where, for any reason, sowings have been done later, the yield is reasonable and bad boll opening reduced. Normal agricultural practice is a balancing of probabilities which have been learned by experience and experiment, and is designed to meet these probabilities. The probability of an intemperate heat and low humidity in May is great.

But, if by an improvement in meteorological forecasting, it were possible to provide information in, say, early April that there was a reasonable probability of a cool May in any year, for that year an alteration in practice would be possible and earlier sowings safely undertaken.

Turning now to the Early Strain figures, it will be noticed that the yields of the Early Strain are considerably above those of 4 F, and that the difference is statistically significant. The difference in yield between the first two sowings, is not significant, but the latest sowing shows a significant decrease in yield. The sowing date effect is the same therefore for the Early Strain as for 4 F. The remarks above, therefore *re*, 4 F would apply *pari passu* to the Early Strain. As this, however, is the first time that the Early Strain has been experimented with in a Sowing Date Experiment, it is impossible to generalise in respect of this variety. There are marked differences between 4 F and Early Strain, both morphologically and physiologically, and it is quite possible that in a normal year 4 F and Early Strain would show differences in their responses to diffent sowing dates.

It will be noticed from Table I that the yields are high. It may be said, in fact, that the year 1930 was good climatically for cotton. The average yield on the Lyallpur Agricultural Farm for 4 F was 11·6 maunds per acre and for 289 F at the British Cotton Growing Association Farm, Khanewal, 11·7 maunds per acre. A reference to Table I in "A Study of Causes Contributing to the Large Variations in Yields from year to year of 4 F Cotton in the Punjab" (Trought, 1931) shows that

these yields are well up to average in spite of the severe attack of insect pests. It may, therefore, be argued that the reversal of results obtained in 1930 with 4 F is not so much due to decreased yields from later sowings as to increased yields from earlier sowings owing to the absence of those checks to the crop's development and growth which would normally occur during May and in consequence its greater power of resistance to insect pests later. The advantages of an accurate forecast of May temparatures are obvious.

## Summary.

The results of the 1930 Sowing Date Experiment differ from those of previous years. This is attributed to the particularly mild season and it is shown that these results support the arguments previously advanced in favour of later sowings in normal or severe seasons.

## Acknowledgments.

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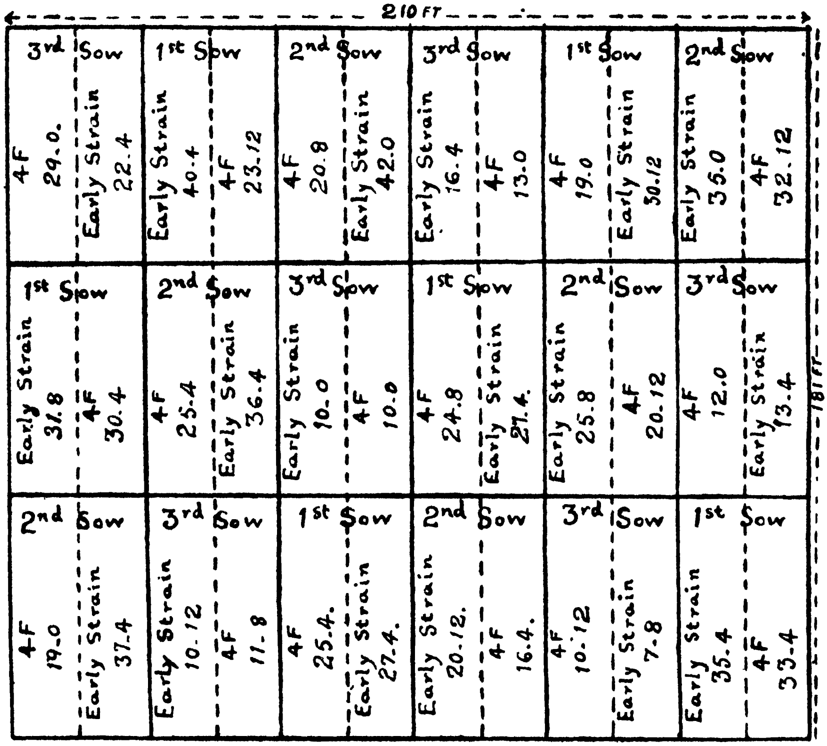
### Table I.

*Tabulated yields of the Sowing Date Experiment, Lyallpur, 1930.*

| Variety | I Picking 27th, 28th October 1930 | II Picking 25th, 26th November 1930 | III Picking 19th January 1931 | Total of all picks | Yield in maunds acre |
|---|---|---|---|---|---|
| | lbs. | lbs. | lbs. | lbs. | |
| Early Strain I Sow . | 1,241 0 | 124 15 | 27 3 | 1,393 2 | 16·95 |
| 4 F I Sow . . | 646 12 | 445 10 | 38 1 | 1,130 7 | 13·75 |
| Early Strain II Sow . | 1,130 8 | 255 5 | 39 15 | 1,425 12 | 17·35 |
| 4 F II Sow . . | 384 0 | 558 0 | 130 7 | 1,072 7 | 13·05 |
| Early Strain III Sow | .. | 432 15 | 146 12 | 579 11 | 7·05 |
| 4 F III Sow . | .. | 461 15 | 163 6 | 625 5 | 7·60 |

PLAN OF SOWING DATE EXPERIMENT 1930




REFERENCE

FIG I

1st Sow ... 24th March
2nd Sow. 1st May
3rd Sow 9th June.
(Yields per bed of area 0·023 ac are inserted - in lbs)

## STATISTICAL NOTE ON THE SOWING DATE EXPERIMENT AT LYALLPUR, 1930.

The plot of land was divided into 6 blocks of 3 patches, each of which was sub-divided into 2 beds in one of which 4 F was sown and in the other the Early Strain. The lay-out therefore admits of the analysis of variance as applied to randomised blocks. The table below gives the results of the analysis :—

*Analysis of Variance.*

| Variance due to | Degrees of freedom | Sum of squares | Mean Square | ½ $\log_e$ (Mean Square) |
|---|---|---|---|---|
| Blocks . . . . . . | 5 | 426·24 | 85·25 | 2·2228 |
| * Treatments . . . | 2 | 1,689·30 | 844·65 | 3·3694 |
| Between patches having the same treatments. | 10 | 424·71 | 42·47 | 1·8744 |
| Varieties . . . | 1 | 239·04 | 239·04 | 2·7382 |
| Differential response of the different treatments. | 2 | 196·27 | 98·14 | 2·2931 |
| Differential response in patches having the same treatment. | 15 | 296·14 | 19·74 | 1·4912 |
| Total . | 35 | 3,271·70 | ... | ... |

* Three dates of sowing, namely 24th March, 1st May and 9th June.

Some outstanding conclusions from the above analysis are :—

(1) Irrespective of sowing date differences, the Early Strain gives a significantly higher yield than 4 F—(Difference of 2·5 maunds per acre)—($Z=1·056$, but the 5 per cent. value is only 0·7466).

(2) Both in 4 F and in Early Strain the sowing date differences cause a significant variation in yield, *i.e.*, the effect of treatment is statistically significant. ($Z=1·495$ and the 5 per cent. value is only 0·7053.) This significance holds also for the 1 per cent. level. For $n_1=2$ and $n_2=10$, the 1 per cent. point is only 1·0114.

(3) Testing for significance of differential response of the varieties to the sowing date differences, the Z-test again shows significance. ($Z=0·8019$ and the 5 per cent. point is 0·6318.) But the nature of the differences are the same both in 4 F and in Early Strain, *viz.*, the 1st and 2nd sowings are in both cases significantly

higher yielding than the 3rd sowing, while between the 1st and 2nd sowings there is no significant difference (see Table below). However, in the case of Early Strain the differences are of a significantly higher order than in 4 F.

*Yield in lbs. (Totals of 6 plots of ·023 acres each.)*

| Variety | I Sow (24th March) | II Sow (1st May) | III Sow (9th June) | Mean | S. E. |
|---|---|---|---|---|---|
| 4 F . . . . . | 156·2 | 134·7 | 86·3 | 125·7 | 14·2* |
| Early Strain . . . . | 192·5 | 196·9 | 80·2 | 156·5 | |

* For totals of 6 plots.

# THE USE OF SULPHUR IN THE CONTROL OF RED-LEAF BLIGHT.

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## I. INTRODUCTION.

In the Kumpta-Dharwar area of the Bombay Presidency, Dharwar-American cotton suffers from a leaf-disease which is commonly known as red-leaf blight. The disease is very serious in Belgaum and Bijapur districts and the cultivation of American types is, for this reason, unsuccessful in these districts. Conditions, however, are favourable in Dharwar, particularly in the eastern talukas. The blight, here, appears rather periodically, causing serious damage once in five years. If it is possible for us successfully to control the trouble, the cotton crop on about two lakhs of acres can be rendered more certain. The prospects of extending the cultivation of American cotton in other districts can also be improved.

## II. RED-LEAF BLIGHT.

Leaves turn brown or red during all stages of growth. The colouring first appears at the margins and extends inwards. In severe attacks, the whole lamina becomes red with the exception of the veins. The seedlings succumb easily. Later on the death-rate is small, but the affected individuals become more or less crippled. So far, no pathogene has been isolated from the coloured patches. Butler [ 1908 ] considers it to be purely a physiological effect of an unfavourable, external environment. We, however, find that the trouble is definitely associated with certain sucking insects of which Jassids (*Chlorita fascialis*) are the chief.

Asiatic cottons, on the whole, are immune to red-leaf blight. Quite a large number of these have been grown at Dharwar, side by side with the Americans and no leaf-discolouration is observed in any. Among the Americans, the susceptibility varies, glabrous types being more susceptible than hairy. The senior writer [Kottur,

1922] has succeeded in selecting a resistant strain, Gadag No. I, from the hairy type, which has almost entirely replaced the ordinary Dharwar-American variety. Even this suffers seriously in some years. We also believe that it is not as resistant as it once was. This is partly due to the increased attack of thrips which have no dislike for hairy cotton, and partly to the total absence of the glabrous type from a large area which has probably driven the Jassids to accommodate themselves to the hairy cotton.

## III. Experiment with sulphur.

Breeding types of cotton more resistant to red-leaf blight is in progress, but other remedial measures have also been tried and among these sulphur-dusting seems to be the most effective.

A low-lying plot of ten *gunthas*, which generally gets the worse attack of red-leaf blight, was selected at Dharwar and Gadag No. I cotton, a pure-line selection of Dharwar-American sown. The plot was divided after sowing into five equal portions and the crop on the first, third and fifth divisions was dusted with sulphur. The second and fourth divisions were maintained as checks and did not receive any treatment. Sulphur-dust of 200-mesh fineness was dusted with a " Peerless " dust-gun. The first dusting was given at the end of August, when the crop was only 21 days old. Subsequently the operation was repeated at intervals of about a fortnight, throughout the growing period. In all, eight dustings were given, the last one being done on the 23rd of December.

Careful observations were made on the following points in the dusted and non-dusted crop :—

(*a*) Stand of the crop.

(*b*) Vigour of growth.

(*c*) Extent of red-leaf blight.

(*d*) Flowering.

(*e*) Yield.

(*a*) *Stand of the crop.*—The season of 1930-31 was very favourable for both thrips and Jassids. During the dry weather that followed immediately after sowing in August, thrips appeared and caused considerable damage to the young crop. As a result, 9 per cent. of the crop died in the dusted crop and 23 per cent. in the non-dusted.

(*b*) *Vigour of growth.*—In the third week of September *rabi* rains commenced and continued during the whole month of October. Thrips entirely disappeared

and the cotton crop made good progress during this period. The dusted and non-dusted plots consequently had equally good growth on them. The average height of plants was 23·7 inches in the dusted and 22·2 in the non-dusted crop, which shows that the two crops were of equal vigour.

(c) *Extent of red-leaf blight.*—The *rabi* rains were more heavy than usual. So after their cessation, Jassids made their appearance. They increased enormously during November and the first half of December. The difference during this period between the dusted and non-dusted plots was very remarkable. The former looked green and healthy, while the latter turned completely red. The extent of the blight, as carefully estimated by eye-inspection, is given below :—

TABLE I.

*Showing the extent of red-leaf blight in the dusted and non-dusted crop.*

| Name of crop | Number of plants examined | Average No. of leaves per plant | Percentage of leaves | | | | |
|---|---|---|---|---|---|---|---|
| | | | Free completely | ¼ area affected | ½ area affected | ¾ area affected | Completely affected |
| Dusted | 20 | 168 | 93·0 | 5·6 | 2·4 | 0 | 0 |
| Non-dusted | 20 | 175 | 12·6 | 14·7 | 24·8 | 18·3 | 29·6 |

(d) *Flowering.*—Both crops commenced flowering in the third week of November and continued till the middle of February. The following shows the intensity of flowering in the dusted and non-dusted crops :—

TABLE II.

*Showing the number of flowers produced per hundred plants.*

| Name of crop | Number of flowers per hundred plants | | | | |
|---|---|---|---|---|---|
| | November | December | January | February | Total |
| Dusted | 17 | 67 | 1,238 | 410 | 1,732 |
| Non-dusted | 10 | 47 | 796 | 164 | 1,017 |

(e) *Yield*:—The dusted plots not only produced more flowers but they also produced a greater number of bolls and consequently the difference in yield was remarkable as shown in the following statement:—

TABLE III.

*Showing the yields of kapas per acre.*

| Name of crop | Sub-plot No. | Treatment | Field of kapas per acre in lbs. | |
|---|---|---|---|---|
| Gadag No. I . . . | 1 | Dusted . | 539 | |
| Ditto . . . | 3 | Do. . | 392 | |
| Ditto . . . | 5 | Do. . | 283 | Average 405 lbs. |
| Ditto . . . | 2 | Non-Dusted . | 258 | |
| Ditto . . . | 4 | Do. . | 174 | Average 216 lbs. |

## IV. CONCLUSIONS.

Shulphur-dusting has thus proved to be very successful in controlling the red-leaf blight of American cottons at Dharwar. Although the number of dustings and the quantity of sulphur used in each dusting was more than what was exactly necessary, the plants did not suffer in any way. The shedding of leaves and flowers reported by Thakar and Desai [1929] was not observed. To ascertain whether American cottons had any advantage in this respect over Indian varieties, dusting was done on the local Kumpta cotton in December, when the cotton was in full flower. Four days after, the flowers began to shed. This was followed by the shedding of almost all the primary leaves. The shedding of buds and flowers continued for about a week after which plants recovered and began to put forth new buds. This shows that Indian cottons are affected by sulphur-dusting, especially when dusting is done during the flowering period. No such effect was noticed in the case of American cotton. Sulphur is becoming a general remedy for many insects and fungoid pests, but in some cases the effects of dusting are harmful. The fact that sulphur checks the red-leaf blight and has at the same time no injurious consequences, is of great value for all growers of American cotton in this country.

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# SELECTED ARTICLES

## CALF REARING ON MILK SELLING FARMS.

BY

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### IMPORTANCE OF CALF REARING.

There are many points in dairy herd management where there is room for legitimate differences of opinion, but there will be almost universal agreement that a herd of cows maintained entirely by the introduction of home-bred stock is less subject to disease and is a greater asset to its owner and to the country than one maintained by the purchase of cows in full milk. From this point of view, therefore, there is a strong case to be made out in favour of an increase in calf-rearing and the development of self-contained herds.

During the last 10 to 15 years there has also been a great development of milk recording, and the information thereby gained by herd owners has been invaluable as an aid to the discovery of the non-paying cow and as a guide to more efficient and economical feeding, but real improvement amongst dairy herds can only come by the use of good dairy bulls and by a just interpretation of milk records in the selection of both bulls and cows for breeding purposes. The schemes now being devised for the elimination of "scrub" bulls also direct attention to the need for greater care in the breeding of dairy and other stock, and an almost inevitable result will be a renewed interest in the rearing of calves.

### CONDITIONS ON MILK-SELLING FARMS.

On many farms where milk is sold, the calf is looked on as little more than a nuisance to be got rid of as soon as possible. No doubt good reasons exist for the maintenance of only cows in milk on farms close to towns where there is a ready market for all the milk produced, but there are many other dairy farms devoted to milk-selling where calf-rearing could be carried on and increased to the ultimate improvement of the herd in almost every respect. One of the difficulties supposed to exist on such farms is that of sparing a sufficient amount of whole milk to give the calves a good start and in view of the value of new milk for direct sale, there are obvious reasons why as much as possible should be sold. On some farms there are also difficulties of accommodation, but in most instances, a little ingenuity and determination, directed to the adaptation of some existing building, can provide all the housing needed.

Since the purchase of a farm in 1920 for the use of the National Institute for Research in Dairying, much attention has been given to the rearing of a home-bred dairy herd free from disease and gradually improving in type and milk yield. This policy involved the rearing of a considerable number of heifer calves each year, and. as there was a keen demand for the milk produced, either for sale or for experimental work, the problems associated with the rearing of calves successfully on the minimum amount of whole milk and by simple and economical methods, has received continuous attention. The remainder of this paper will be mainly devoted to a description of the manner in which the problems were studied and the results obtained.

## Whole Milk Substitutes.

The first problem was to find an efficient milk substitute, and this question was tackled in two ways. Firstly, the composition of milk was studied and mixtures of cake, meal and grain were made up to approximate as closely as possible to whole milk. Secondly, the palatability of individual foods to young calves was studied by the free choice system of feeding, so that those foods might be selected which calves ate readily at an early age. It will be apparent that, however closely a mixture might approximate to new milk in composition, it would not be satisfactory if it were not palatable and readily eaten by the calves.

## Dry Feeding *versus* Gruels.

It was also decided that the milk substitute should be given in the form of dry foods, in order to save the time, care and labour required for the correct preparation and feeding of gruels. Experiments at the Midland Agricultural College by Dunlop in 1915[1] and by Voelcker at Woburn in 1912-17[2] had shown that gruels were not essential, but further work appeared necessary to find out which mixtures of easily obtainable dry foods would prove most satisfactory. Meal mixtures prepared on the farm or purchased as proprietary calf meals and prepared by boiling for feeding as gruels have long been known to take the place of milk after the calf is a few weeks old, but, to get the best results, the meal must be mixed with water in the correct proportion, the gruel boiled or scalded and given to the calves at a temperature of 95° to 100° F., and the pails in which it is given must be kept clean. It is comparatively rare to find all the above points receiving adequate attention with the result that gruels are often made too watery or too hot, and the calf's nose is scalded, or too cold and indigestion is caused, or each calf does not get its fair share, or the pails are dirty and are a probable cause of scour. It is not uncommon to find gruel-fed calves pot-bellied, with staring coats of unthrifty appearance. Further the prices charged for proprietary calf meals are often very high and out of proportion to the real nutritive value of the ingredients.

1. Report on Calf Feeding Experiments with Milk Substitutes, Dunlop and Bailey.
2. Calf Rearing Experiments at Woburn, 1912-17. J. A. Voelcker, J. R. A. S. E. 1917.

### How Cake and Meal Mixtures Compare with Whole Milk.

To provide a basis for comparison, the weight of the different food ingredients in one gallon of whole milk was calculated. Attempts were then made to build up mixtures of easily obtainable foods which would resemble the milk in composition. Several definite differences were soon observed in most of the mixtures considered, for example (*a*) all mixtures of dry foods contain a greater or lesser proportion of indigestible fibre, whereas milk contains no indigestible matters ; (*b*) milk contains slightly more fat than protein, whereas, in all ordinary foods with the exception of linseed, the proportion of protein considerably exceeds the proportion of oil ; (*c*) milk contains lime and phosphoric acid in appreciable and approximately similar amounts, whereas most common feeding stuffs (with the exception of fish-meal) contain little lime and much more phosphoric acid.

Table I (page 644) gives in a concise form the weight of food constituents in one gallon of whole milk, and in equivalent weights of a number of mixtures of common foods.

In table I, all the mixures show a very marked deficiency of fat when compared with whole milk. To a certain extent this is made up for by a slight increase in the digestible carbohydrates, and had linseed been included in any of the mixtures, the oil content would have been increased. In mixture A, which consists of equal weights of linseed cake and crushed oats—popular foods for the rearing of calves—there is also a marked deficiency of lime, but the use of fish-meal in mixtures B to E ensures a sufficiency of lime, and the proportion of lime to phosphoric acid more nearly resembles the proportions existing in whole milk. The fibre content is greatest in mixture A, and is considerably lessened in the other mixtures by the use of foods with a notably low fibre content, *e.g.*, maize meal, flaked maize and locust bean meal. Numerous other mixtures could be made up to approximate as closely as any of the above to the composition of whole milk, but selection in this case was controlled by the preference shown for certain foods in the "free-choice" tests, and by the desire to use only foods which could be readily obtained by any farmer.

### Free-Choice Feeding Trials—Experiment A.

The first experiment on the palatability of foods for calves was conducted by means of two calves in separate pens, each provided with a choice of four or five different foods at the same time. A trough with five compartments was placed within the reach of each calf and weighed quantities of the different foods were placed in each compartment ; twice daily the amount of each food left by each calf was removed and weighed so that an accurate record was obtained of the quantity of each food eaten daily ; weekly records of the live weight of each calf were also kept. The foods offered to the calves were changed from time to time, and those

TABLE I.

*Comparative composition of whole milk and certain meal and cake mixture.*

| — | | Digestible Protein Equivalent. | Digestible Fat. | Digestible Carbo-Hydrates. | Starch Equivalent. | Lime (CaO). | Phosphoric Acid ($P_2O_5$). | Fibre. |
|---|---|---|---|---|---|---|---|---|
| | | lb. | lb. | lb. | lb. | lb. | lb. | lb. |
| 1 gallon whole milk = 1⅓ lbs. milk solids | contains | 0·32 | 0·39 | 0·48 | 1·71 | 0·017 | 0·020 | *Nil.* |
| A { Linseed Cake . . . 1 part; Oats (Crushed) . . . 1 „ } | 1⅓ lb. contains | 0·245 | 0·096 | 0·60 | 1·01 | 0·005 | 0·020 | 0·146 (=9·7%) |
| B { Linseed Cake . . . 4 parts; Maize Meal . . . 3 „; Fish Meal . . . 1 part } | 1½ lb. contains | 0·31 | 0·095 | 0·63 | 1·11 | 0·024 | 0·028 | 0·081 (=5·4%) |
| C { Linseed Cake . . . 4 parts; Oats (Crushed) . . 2 „; Maize Flakes . . . 2 „; Sharps . . . 1 part; Fish Meal . . . 1 „ } | 1⅓ lb. contains | 0·29 | 0·083 | 0·63 | 1·05 | 0·020 | 0·028 | 0·105 (=7·0%) |
| D { Linseed Cake . . . 4 parts; Bean Meal . . . 4 „; Oats (Crushed) . . . 3 „; Maize Flakes . . . 3 „; Fish Meal . . . 1 part } | 1⅓ lb. contains | 0·28 | 0·06 | 0·68 | 1·04 | 0·014 | 0·025 | 0·100 (=6·6%) |
| E { Linseed Cake . . . 4 parts; Maize Flakes . . . 2 „; Oats (Crushed) . . 1½ „; Locust Bean Meal . . 1½ „; Fish Meal . . 1 part } | 1⅓ lb. contains | 0·27 | 0·075 | 0·67 | 1·07 | 0·019 | 0·025 | 0·096 (=6·5%) |

given comprised linseed cake, bran, crushed wheat, crushed oats, crushed barley, maize meal and fish-meal.

Table II (pages 646-649) gives the age and treatment of each calf previous to the commencement of the free-choice feeding, It will be seen that calf No. 33 had had about 26 gallons whole milk and had been accustomed to dry foods by the age of six weeks, and calf No. 32 had had about 39 gallons of whole milk and been brought on to dry feeding alone by the age of 7½ weeks. The table shows the quantities of each food and the total amount eaten daily by each calf during a period of 40 days.

*Results.*—A study of the different columns shows a definite preference for certain foods by each of the two calves. No. 33 undoubtedly preferred linseed cake and crushed barley at first, acquiring a taste for crushed oats later and taking smaller and varying amounts of maize meal from day to day. No. 32 preferred linseed cake, maize meal and crushed oats with varying quantities of barley meal; crushed wheat and bran were apparently not so attractive. With regard to fish-meal, two points are of interest; both calves took small amounts of this food regularly, seldom omitting it on two succesive days and No. 32 ate from two to six ounces daily when the other foods available consisted only of cereals and bran; when linseed cake was introduced the consumption of fish-meal fell off considerably but a few ounces were taken every few days.

*Quantity of Dry Foods Eaten.*—Another point which the table illustrates is that calves from the age of seven to eight weeks will eat readily and without any bad effects a considerably larger allowance of dry cake, grain and meal than is usually suggested or offered them. These two calves, before attaining the age of two months ate daily from 2 to 3 lb. of cake, etc., and by the age of three months were eating from 3½ to 4 lb. daily. In addition to the foods mentioned good hay and clean water were supplied daily, but no record was kept of the quantities consumed.

### Free-Choice Feeding Trials—Experiment B.

A second free-choice experiment was carried out at a later date to obtain further information on the subject. In this experiment, of which details are given in Table III (pages 650-653) for a period of three weeks the amount of each food offered daily was in excess of the amount eaten the previous day, so that if a calf preferred it could satisfy itself on one concentrate only; also a record was kept of the weight of hay eaten and water drunk by each calf daily.

*Part I.—Results.*—Both calves were eight weeks old at the commencement of the experiment and had been gradually weaned from whole milk to dry foods as in the first experiment. During the first three weeks, calf No. 103 showed a decided

## Table II.

## SELECTION OF FOODS BY CALVES—EXPERIMENT A.

### Calf No. 33 (Heifer).

Born 28th November, 1921. Four days suckling dam, then 1 gallon whole milk daily for 15 days, thereafter diminishing amounts of whole milk, supplemented by dry meals from 26th December, 1921, to 8th January, 1922.

Total whole milk . . . . 289 lb.

*Maximum weight of each Food offered daily to each Calf.*

| — | Linseed Cake. | Crushed Oats. | Crushed Wheat. | Crushed Barley. | Maize Meal. | Fish Meal. | Total Weight. |
|---|---|---|---|---|---|---|---|
| | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. |
| January 8-21 . | 16 | 16 | 16 | 16 | 0 | 0 | 64 |
| " 22—February 17. | 16 | 16 | 0 | 16 | 16 | 8 | 72 |

*Weight of each Food actually eaten daily by each Calf.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| January 8 (½ day) . | 8 | .. | 1 | 2 | .. | .. | 11 |
| " 9 . . | 16 | 1 | 1 | 16 | .. | .. | 34 |
| " 10 . . | 16 | 1 | 0 | 16 | .. | .. | 33 |
| " 11 . . | 16 | 1 | 8 | 16 | .. | .. | 41 |
| " 12 . . | 16 | 0 | 1 | 16 | .. | .. | 33 |
| " 13 . . | 16 | 1 | 2 | 16 | .. | .. | 35 |
| " 14 . . | 16 | 1 | 5 | 16 | .. | .. | 38 |
| " 15 . . | 16 | 3 | 4 | 16 | .. | .. | 39 |
| " 16 . . | 16 | 0 | 0 | 16 | .. | .. | 31 |
| " 17 . . | 16 | 0 | 5 | 16 | .. | .. | 37 |
| " 18 . . | 16 | 1 | 5 | 16 | .. | .. | 38 |
| " 19 . . | 16 | 1 | 5 | 16 | .. | .. | 38 |
| " 20 . . | 16 | 8 | 10 | 16 | .. | .. | 50 |
| " 21 . . | 16 | 1 | 4 | 16 | .. | .. | 37 |
| " 22 . . | 16 | 7 | .. | 16 | 6 | 6 | 51 |

TABLE II—*contd.*

## SELECTION OF FOODS BY CALVES—EXPERIMENT A—*contd.*

*Weight of each Food actually eaten daily by each Calf*—contd.

| — | Linseed Cake. | Crushed Oats. | Crushed Wheat. | Crushed Barley. | Maize Meal. | Fish Meal. | Total Weight. |
|---|---|---|---|---|---|---|---|
| | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. |
| January 23 . | 16 | 6 | .. | 16 | 5 | 2 | 45 |
| „ 24 . . | 16 | 7 | .. | 16 | 6 | 1 | 46 |
| „ 25 . . | 16 | 2 | .. | 16 | 7 | 1 | 42 |
| „ 26 . . | 16 | 1 | .. | 16 | 1 | 2 | 36 |
| „ 27 . . | 16 | 7 | .. | 16 | 6 | 1 | 46 |
| „ 28 . . | 16 | 16 | .. | 16 | 6 | 0 | 54 |
| „ 29 . . | 16 | 13 | .. | 16 | 9 | 0 | 54 |
| „ 30 . . | 16 | 15 | .. | 16 | 10 | 1 | 58 |
| „ 31 . . | 16 | 16 | .. | 16 | 5 | 0 | 53 |
| February 1 . | 16 | 16 | .. | 16 | 5 | 2 | 55 |
| „ 2 . | 16 | 16 | .. | 16 | 8 | 1 | 57 |
| „ 3 . | 16 | 16 | .. | 16 | 5 | 2 | 55 |
| „ 4 . | 16 | 16 | .. | 16 | 10 | 4 | 62 |
| „ 5 . | 16 | 16 | .. | 16 | 7 | 2 | 57 |
| „ 6 . | 16 | 16 | .. | 16 | 14 | 2 | 64 |
| „ 7 . | 16 | 16 | .. | 16 | 16 | 2 | 56 |
| „ 8 . | 16 | 16 | .. | 16 | 8 | 1 | 57 |
| „ 9 . | 16 | 16 | .. | 16 | 5 | 1 | 54 |
| „ 10 . | 16 | 16 | .. | 16 | 4 | 1 | 53 |
| „ 11 . | 16 | 16 | .. | 16 | 9 | 3 | 60 |
| „ 12 . | 16 | 16 | .. | 16 | 3 | 4 | 55 |
| „ 13 . | 16 | 16 | .. | 16 | 3 | 1 | 52 |
| „ 14 . | 16 | 16 | .. | 16 | 4 | 2 | 54 |
| „ 15 . | 16 | 14 | .. | 16 | 6 | 3 | 55 |
| „ 16 . | 16 | 12 | .. | 16 | 6 | 1 | 51 |
| „ 17 . | 16 | 13 | .. | 16 | 6 | 2 | 53 |

TABLE II—*contd.*

SELECTION OF FOODS BY CALVES—EXPERIMENT A—*contd.*

CALF NO. 32 (BULL).

**Born 16th November, 1921. Four days suckling dam, then 1 gallon whole milk daily for 20 days, thereafter diminishing amounts of whole milk, supplemented by dry meals from 26th December, 1921, to 8th January, 1922.**

**Total whole milk—399 lb.**

***Maximum weight of each Food offered daily to each Calf.***

| — | Crushed Oats. | Bran. | Maize Meal. | Fish Meal. | Linseed Cake. | Crushed Barley. | Total Weight. |
|---|---|---|---|---|---|---|---|
| | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. |
| January 8-21 . . . . . | 16 | 16 | 16 | 8 | 0 | 0 | 56 |
| „ 22—February 17 . . | 16 | 0 | 16 | 8 | 16 | 16 | 72 |
| ***Weight of each Food actually eaten daily by each Calf.*** | | | | | | | |
| January 8 (½ day) . . . . | 8 | 8 | 2 | 2 | .. | .. | 20 |
| „ 9 . . . . . | 16 | 9 | 2 | 4 | .. | .. | 31 |
| „ 10 . . . . . | 16 | 14 | 1 | 3 | .. | .. | 34 |
| „ 11 . . . . . | 16 | 10 | 12 | 5 | .. | .. | 43 |
| „ 12 . . . . . | 15 | 10 | 15 | 6 | .. | .. | 46 |
| „ 13 . . . . . | 16 | 8 | 16 | 4 | .. | .. | 44 |
| „ 14 . . . . . | 16 | 6 | 16 | 5 | .. | .. | 43 |
| „ 15 . . . . . | 16 | 8 | 16 | 6 | .. | .. | 46 |
| „ 16 . . . . . | 16 | 6 | 16 | 5 | .. | .. | 43 |
| „ 17 . . . . . | 16 | 10 | 16 | 5 | .. | .. | 47 |
| „ 18 . . . . . | 16 | 6 | 16 | 4 | .. | .. | 42 |
| „ 19 . . . . . | 16 | 11 | 16 | 5 | .. | .. | 48 |
| „ 20 . . . . . | 16 | 8 | 16 | 5 | .. | .. | 45 |
| „ 21 . . . . . | 16 | 4 | 15 | 4 | .. | .. | 39 |
| „ 22 . . . . . | 12 | .. | 14 | 2 | 16 | 15 | 59 |
| „ 23 . . . . . | 10 | .. | 14 | 0 | 16 | 16 | 56 |

TABLE II—*concld.*

## SELECTION OF FOODS BY CALVES—EXPERIMENT A—*concld.*

*Weight of each Food actually eaten daily by each Calf*—contd.

| — | Crushed Oats. | Bran. | Maize Meal. | Fish Meal. | Linseed Cake. | Crushed Barley. | Total Weight. |
|---|---|---|---|---|---|---|---|
| | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. | Ozs. |
| January 24 . . . . . | 11 | .. | 12 | 0 | 16 | 15 | 54 |
| „ 25 . . . . . | 11 | .. | 14 | 1 | 15 | 0 | 41 |
| „ 26 . . . . . | 16 | .. | 13 | 2 | 16 | 1 | 48 |
| „ 27 . . . . . | 16 | .. | 13 | 2 | 16 | 5 | 52 |
| „ 28 . . . . . | 16 | .. | 15 | 1 | 15 | 5 | 52 |
| „ 29 . . . . . | 16 | .. | 16 | 0 | 15 | 4 | 51 |
| „ 30 . . . . . | 16 | .. | 14 | 1 | 14 | 5 | 50 |
| „ 31 . . . . . | 16 | .. | 12 | 0 | 16 | 10 | 54 |
| February 1 . . . . . | 16 | .. | 13 | 0 | 15 | 1 | 45 |
| „ 2 . . . . . | 16 | .. | 16 | 1 | 16 | 10 | 59 |
| „ 3 . . . . . | 12 | .. | 16 | 0 | 16 | 16 | 60 |
| „ 4 . . . . . | 16 | .. | 16 | 2 | 16 | 16 | 66 |
| „ 5 . . . . . | 10 | .. | 16 | 1 | 16 | 8 | 51 |
| „ 6 . . . . . | 12 | .. | 16 | 2 | 16 | 15 | 61 |
| „ 7 . . . . . | 16 | .. | 16 | 1 | 16 | 16 | 65 |
| „ 8 . . . . . | 12 | .. | 16 | 0 | 16 | 14 | 58 |
| „ 9 . . . . . | 14 | .. | 16 | 1 | 16 | 16 | 63 |
| „ 10 . . . . . | 14 | .. | 16 | 2 | 16 | 16 | 64 |
| „ 11 . . . . . | 16 | .. | 16 | 1 | 16 | 16 | 65 |
| „ 12 . . . . . | 13 | .. | 16 | 0 | 14 | 16 | 59 |
| „ 13 . . . . . | 14 | .. | 16 | 0 | 14 | 16 | 60 |
| „ 14 . . . . . | 14 | .. | 16 | 0 | 9 | 16 | 55 |
| „ 15 . . . . . | 14 | .. | 16 | 3 | 14 | 13 | 60 |
| „ 16 . . . . . | 13 | .. | 16 | 1 | 12 | 14 | 56 |
| „ 17 . . . . . | 12 | .. | 16 | 2 | 14 | 16 | 60 |

## Table III.

## SELECTION OF FOODS BY CALVES—EXPERIMENT B.

### Calf No. 103 (Heifer).

Born 19th November, 1924. Four days suckling dam, then 1 gallon whole milk daily for 21 days, thereafter diminishing amounts supplemented by dry mixture. No milk after 20th January, 1925.

*Foods offered daily to each calf and amounts eaten—Part I.*

| Date. | Linseed Cake. | Bran. | Maize Meal. | Crushed Oats. | Crushed Barley. | Total Weight eaten daily. | Clover Hay. | Water. |
|---|---|---|---|---|---|---|---|---|
| 1925. | ozs. | ozs. | ozs. | ozs. | ozs. | ozs. | ozs. | lb. |
| January 21 . . | 32 | 16 | .. | .. | .. | 48 | 8 | 10 |
| „ 22 . . | 38 | 17 | .. | .. | .. | 55 | 8 | 12 |
| „ 23 . | 54 | 9 | .. | .. | 4 | 67 | 12 | 12 |
| „ 24 . . | 48 | 10 | .. | 2 | 5 | 65 | 8 | 12 |
| „ 25 . . | 54 | 12 | .. | .. | 2 | 68 | 8 | 10 |
| „ 26 . . | 53 | 20 | .. | .. | 4 | 77 | 6 | 13 |
| „ 27 . . | 42 | 26 | .. | .. | 7 | 75 | 7 | 12 |
| „ 28 . . | 50 | 22 | .. | .. | .. | 72 | 12 | 15 |
| „ 29 . . | 55 | 26 | .. | .. | 4 | 85 | 7 | 15 |
| „ 30 . . | 41 | 26 | .. | 2 | 5 | 74 | 9 | 15 |
| „ 31 . . | 54 | 26 | .. | 1 | 5 | 86 | 7 | 16 |
| February 1 . . | 55 | 28 | .. | .. | 7 | 90 | 6 | 17 |
| „ 2 . . | 50 | 25 | .. | .. | .. | 75 | 7 | 17 |
| „ 3 . . | 48 | 25 | .. | .. | 2 | 75 | 5 | 16 |
| „ 4 . . | 58 | 27 | .. | 2 | 4 | 91 | 3 | 18 |
| „ 5 . . | 56 | 22 | .. | 2 | 3 | 83 | 6 | 17 |
| „ 6 . . | 57 | 17 | .. | 2 | .. | 76 | 7 | 18 |
| „ 7 . . | 55 | 22 | .. | 4 | 6 | 87 | 5 | 17 |
| „ 8 . . | 58 | 26 | .. | 3 | 2 | 89 | 7 | 17 |
| „ 9 . . | 59 | 22 | .. | 3 | 10 | 94 | 5 | 17 |

**Gain in live weight—1·45 lb. daily.**

TABLE III—*contd.*

## SELECTION OF FOODS BY CALVES—EXPERIMENT B—*contd.*

### CALF No 104 (HEIFER).

Born 21st November, 1924. Four days suckling dam, then 1 gallon whole milk daily for 21 days, thereafter diminishing amounts supplemented by dry mixture. No milk after 20th January 1925.

*Foods offered daily to each calf and amounts eaten—Part I.*

| | Linseed Cake. | Bran. | Maize Meal. | Crushed Oats. | Crushed Barley. | Total Weight eaten daily. | Clover Hay. | Water. |
|---|---|---|---|---|---|---|---|---|
| 1925. | ozs. | ozs. | ozs. | ozs. | ozs. | ozs. | ozs. | lb. |
| January 21 . . | 16 | 17 | .. | .. | .. | 33 | 8 | 8 |
| ,, 22 . . | 20 | 10 | .. | .. | 6 | 36 | 12 | 8 |
| ,, 23 . . | 33 | .. | .. | .. | 5 | 38 | 12 | 10 |
| ,, 24 . . | 34 | 5 | .. | .. | 5 | 44 | 8 | 10 |
| ,, 25 . . | 35 | 7 | .. | .. | 6 | 48 | 8 | 10 |
| ,, 26 . . | 47 | .. | .. | .. | 6 | 53 | 8 | 8 |
| ,, 27 . . | 37 | 7 | .. | .. | 6 | 50 | 6 | 6 |
| ,, 28 . . | 48 | 13 | .. | .. | 9 | 70 | 7 | 12 |
| ,, 29 . . | 30 | 3 | .. | .. | 13 | 46 | 12 | 9 |
| ,, 30 . . | 45 | 8 | .. | 3 | 7 | 63 | 11 | 13 |
| ,, 31 . . | 47 | 9 | .. | 4 | 6 | 66 | 6 | 12 |
| February 1 . . | 48 | 12 | 4 | 5 | 7 | 76 | 6 | 10 |
| ,, 2 . . | 43 | 3 | .. | 6 | 9 | 61 | 7 | 10 |
| ,, 3 . . | 45 | 9 | .. | 4 | 9 | 67 | 5 | 14 |
| ,, 4 . | 42 | 9 | .. | 5 | 9 | 65 | 5 | 12 |
| ,, 5 . . | 45 | | .. | 8 | 14 | 73 | 3 | 15 |
| ,, 6 . . | 47 | .. | . | 7 | 10 | 64 | 5 | 10 |
| ,, 7 . . | 47 | 2 | .. | 6 | 14 | 69 | 6 | 16 |
| ,, 8 . . | 37 | 6 | .. | 8 | 10 | 61 | 7 | 12 |
| ,, 9 . . | 42 | 4 | .. | 5 | 8 | 59 | 3 | 15 |

Gain in live weight—1·25 lb. daily.

TABLE III—*contd.*

SELECTION OF FOODS BY CALVES—EXPERIMENT B—*contd.*

*Foods offered daily to each calf and amounts eaten—Part II.*

| Date. | Linseed Cake. | Bran. | Maize Meal. | Crushed Oats. | Crushed Barley. | Total Weight eaten daily. | Clover Hay. | Water. |
|---|---|---|---|---|---|---|---|---|
| 1925 | ozs. | ozs. | ozs. | ozs. | ozs. | ozs. | ozs. | lbs. |
| * February 10 . . | 24 | 23 | 13 | 8 | 9 | 77 | 12 | 15 |
| „ 11 . . | 31 | 30 | 14 | 11 | 7 | 93 | 8 | 18 |
| „ 12 . . | 32 | 28 | 23 | 2 | .. | 85 | 12 | 12 |
| „ 13 . . | 32 | 30 | 24 | 9 | .. | 95 | 16 | 19 |
| „ 14 . . | 32 | 31 | 32 | .. | .. | 95 | 17 | 19 |
| „ 15 . . | 32 | 31 | 32 | .. | .. | 95 | 16 | 19 |
| „ 16 . . | 32 | 28 | 26 | .. | .. | 86 | 13 | 19 |
| „ 17 . . | 32 | 26 | 27 | 4 | 4 | 93 | 15 | 15 |
| „ 18 . . | 32 | 27 | 29 | 5 | 6 | 99 | 12 | 18 |
| „ 19 . . | 32 | 27 | 31 | 4 | 5 | 99 | 15 | 20 |
| † February 20 . . | 16 | 16 | 16 | 9 | 4 | 61 | 24 | 12 |
| „ 21 . . | 16 | 16 | 16 | 5 | 6 | 59 | 36 | 19 |
| „ 22 . . | 16 | 16 | 16 | 6 | 6 | 60 | 40 | 20 |
| „ 23 . . | 16 | 16 | 16 | 13 | 2 | 63 | 40 | 12 |
| „ 24 . . | 16 | 16 | 16 | 8 | 2 | 58 | 45 | 12 |
| „ 25 . . | 16 | 16 | 16 | 12 | 1 | 61 | 42 | 10 |
| „ 26 . . | 16 | 16 | 16 | 6 | 1 | 55 | 48 | 20 |
| „ 27 . . | 16 | 16 | 16 | 11 | 1 | 60 | 52 | 20 |
| „ 28 . . | 16 | 16 | 16 | 6 | .. | 54 | 48 | 20 |
| March 1 . . | 16 | 16 | 16 | 4 | 2 | 54 | 56 | 20 |

Gain in live weight—1·70 lb. daily.

* February 10-19, Linseed Cake limited to 2 lbs. per head daily.

† February 20—March 1, Linseed Cake, Bran and Barley each limited to 1 lb. per head daily.

TABLE III—*contd.*

## SELECTION OF FOODS BY CALVES—EXPERIMENT B—*contd.*

*Foods offered daily to each calf and amounts eaten—Part II*—contd.

| | Linseed Cake. | Bran. | Maize Meal. | Crushed Oats. | Crushed Barley. | Total Weight eaten daily. | Clover Hay. | Water. |
|---|---|---|---|---|---|---|---|---|
| 1925. | ozs. | ozs. | ozs. | ozs. | ozs. | ozs. | ozs. | lbs. |
| *February 10 . . | 30 | 17 | 14 | .. | 6 | 67 | 9 | 17 |
| „ 11 . . | 31 | 24 | 15 | .. | 8 | 78 | 8 | 18 |
| „ 12 . . | 32 | 18 | 22 | .. | 2 | 74 | 14 | 15 |
| „ 13 . . | 32 | 26 | 24 | .. | .. | 82 | 17 | 18 |
| „ 14 . . | 32 | 31 | 31 | .. | .. | 94 | 12 | 15 |
| „ 15 . . | 32 | 32 | 31 | .. | .. | 95 | 8 | 11 |
| „ 16 . . | 32 | 32 | 29 | .. | .. | 93 | 15 | 8 |
| „ 17 . . | 32 | 24 | 30 | .. | 3 | 89 | 13 | 13 |
| „ 18 . . | 32 | 31 | 29 | .. | 3 | 95 | 8 | 12 |
| „ 19 . . | 32 | 24 | 32 | .. | 2 | 90 | 6 | 11 |
| †February 20 . . | 16 | 16 | 16 | 8 | 7 | 63 | 22 | 12 |
| „ 21 . . | 16 | 16 | 16 | 14 | 5 | 67 | 23 | 12 |
| „ 22 . . | 16 | 16 | 16 | 5 | 2 | 55 | 24 | 15 |
| „ 23 . . | 16 | 16 | 16 | 6 | 6 | 60 | 39 | 15 |
| „ 24 . . | 16 | 16 | 16 | 15 | 2 | 65 | 46 | 18 |
| „ 25 . . | 16 | 16 | 16 | 4 | 3 | 55 | 40 | 11 |
| „ 26 . . | 16 | 16 | 16 | 6 | 5 | 59 | 41 | 14 |
| „ 27 . . | 16 | 16 | 16 | 12 | 2 | 62 | 40 | 16 |
| „ 28 . . | 16 | 16 | 16 | .. | .. | 48 | 48 | 15 |
| March 1 . . | 16 | 16 | 16 | 2 | 3 | 53 | 50 | 10 |

Gain in live weight—1·95 lb. daily.

* February 10-19, Linseed Cake limited to 2 lbs. per head daily.

† February 20—March 1, Linseed cake, Bran and Barley each limited to 1 lb. per head daily.

TABLE IV.

*Live weight Increases of Calves receiving different amounts of whole milk.*

| Whole milk allowances. | No. of calves. | Average live weight at one week. | First 3 weeks. | | Second 3 weeks. | | Third 3 weeks. | | Fourth 3 weeks. | | Fifth 3 weeks. | | Sixth 3 weeks. | | 18 weeks' average live weight gain per head. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average live weight per head. | Gain in live weight per head. | Average live weight per head. | Gain in live weight per head. | Average live weight per head. | Gain in live weight per head. | Average live weight per head. | Gain in live weight per head. | Average live weight per head. | Gain in live weight per head. | Average live weight per head. | Gain in live weight per head. | |
| | | lb. | lb. | lb. | lb. | lb | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. |
| 290 to 304 lb. . . . (Aver. per head 299 lb.) | 4 | 91·5 | 112·5 | 1·00 | 127·75 | 0·73 | 144 | 0·77 | 163·25 | 0·92 | 179·75 | 0·79 | 208 | 1·34 | 0·93 |
| 361 to 427 lb. . . . (Aver. per head 397 lb.) | 6 | 9·5 | 112 | 1·02 | 137 | 1·19 | 156 | 0·91 | 174 | 0·86 | 193 | 0·91 | 216 | 1 09 | 1·00 |
| 443 to 496 lb. . . . (Aver. per head 474 lb.) | 14 | 92·8 | 114·9 | 1·05 | 145·3 | 1·45 | 175·9 | 1·46 | 198·2 | 1·06 | 219·4 | 1·01 | 242·4 | 1·09 | 1·19 |
| 500 to 546 lb. . . . (Aver. per head 525 lb.) | 13 | 93·4 | 113·1 | 0·94 | 140·9 | 1·32 | 169·8 | 1·38 | 196·3 | 1·26 | 219·7 | 1·11 | 248·4 | 1·37 | 1·23 |
| 577 to 610 lb. . . . (Aver. per head 599 lb.) | 13 | 90·9 | 111·1 | 0·96 | 137 | 1·23 | 164·7 | 1·32 | 188·1 | 1·11 | 212·7 | 1·17 | 239·6 | 1·28 | 1·18 |

preference for linseed cake and bran, with frequent additions of crushed barley and occasional very small amounts of crushed oats; calf No. 10 4 was also very fond of linseed cake but preferred crushed barley to bran, and in the latter half of the three-week period ate a small quantity of crushed oats daily. Maize meal in this experiment was not an attractive food.

*Quantity of Dry Foods Eaten.*—Again the quantities of dry concentrates eaten daily were much above normal practice or expectation. Calf No. 103 had the greater appetite and during the 9th, 10th and 11th weeks of its life ate from 3 lb. to 4½ lb. daily; of this amount, from 2 lb. to 3½ lb. consisted of linseed cake. Calf No. 104 ate from 2 lb. to 4 lb. daily of which a similar proportion consisted of linseed cake. During this period both calves grew well, and in addition to the concentrates, they ate an average of ½ lb. clover hay and drank from 1 to 1¾ gallons of water daily.

*Part II.—Results.*—It became apparent that little information would be gained about other foods as long as the daily allowance of linseed cake was unlimited, hence for a ten-day period the linseed cake was restricted to 2 lb. per calf daily, maize meal and crushed oats were omitted and fish meal and a new food—whale meat flakes—were included. During this period, details of which are supplied in Table III (Part II), both calves continued to eat all the linseed cake offered and also showed definite fondness for bran and crushed barley, but ate the fish meal and whale flakes sparingly and irregularly. The daily consumption of hay and water increased considerably.

During the next ten-day period (see Table III, Part II) the linseed cake, bran and crushed barley were each reduced to 1 lb. per calf daily, and the fish meal and whale flakes continued. The amounts of both these foods eaten at once increased and a preference for the whale flakes over the fish meal became apparent; also there was a most marked increase in the amount of hay eaten; whereas, with an unlimited supply of linseed cake, bran and crushed barley the hay consumption ranged from ½ lb. to 1 lb. per head daily, when these concentrates were limited in amount, to 3 lb. per head, the hay consumption increased to 3 to 3½ lb. per head daily. The live weight gain during these two ten-day periods was very good, and, so far as could be judged by weekly weighings, was quite as satisfactory during the second period when hay was eaten freely as during the first period when concentrates were apparently eaten in place of hay.

*Part III.—Results.*—The experiment was continued for a further period of five weeks, during which no linseed cake was given, but crushed barley, bran, crushed oats, fish meal and whale flakes were given in unlimited amounts. Throughout this period the cereals and bran were eaten freely in amounts varying from 5 to 8 lb. per head daily; the consumption of fish meal and whale flakes was slight but regular—

from nil to eight ounces per head daily—and the consumption of hay again fell to from 1 lb. to 2 lb. daily. The live weight gain was less good than in the periods already discussed, being 1·49 lb. per day for calf No. 103 and 1·29 lb. for calf No. 104.

The results of this second experiment as a whole confirm those of the first. Calves will eat dry cake and meals freely from the age of eight weeks, and show a distinct preference for linseed cake, supplemented by cereal grains in the crushed form in varying amounts according to the taste of the individual calf; fish meal is also taken in small amounts and the consumption of hay is dependent on the amount of concentrates available. The question of economy of feeding was not under consideration in these experiments, but there are definite indications that the limitation of suitable concentrates, associated with a sufficiency of good hay will give as good a live weight increase at less cost than giving concentrates in large amounts. The quantity of water taken daily by calves from the age of two to six months ranges from 1 to 2½ gallons daily.

### PRACTICAL REARING TRIALS.

The information obtained from the study of the chemical composition of milk and milk substitute mixtures, and from the free-choice experiments described above was utilised in the rearing of many calves under practical conditions from 1922 onwards.

The system of mangement generally followed was as follows:—Each calf was left with its dam for four days after birth; on the fourth day it was transferred to a pen and for the next three to four weeks it received one gallon whole milk daily—5 lb. (two quarts) in the morning and 5 lb. (two quarts) in the afternoon—just after the milking of the cows, so that milk warm from the cow was available at each meal. During the third or fourth week a little good hay was supplied and handful or so of dried cake and meal mixture given either in the bottom of the milk pail just after each feed of milk, or in a separate trough or pail fixed to the side of the pen. From the fourth or fifth week onwards the daily allowance of whole milk was reduced and the amount of dry mixture increased until by the seventh, eighth or ninth week, the whole milk was stopped entirely and the feeding thereafter consisted of dry cake and meal mixture, good hay and water. Clean water, slightly heated during the winter, was given at the hours when milk had been given, and from 6 to 8 lb. (say three quarts) were given twice daily. No difficulty was experienced in getting the calves to eat the dry mixtures offered them, and scouring or other digestive disturbances have been practically unknown. The dry mixture allowance was increased as quickly as the calf would eat it up to 3 lb. to 4 lb. per head daily.

### Cud-chewing and Digestion of Fibre and Carbo-hydrates.

It was noticed that calves as a rule began to nibble straw or hay and to chew the cud during the third or fourth week, and from that time a small quantity of hay was eaten daily. If calves will eat, enjoy and digest hay when about four weeks old, it is a justifiable inference that they may at the same time be offered concentrates, which are as a rule more digestible than hay. The consumption of hay at this early age should also be considered in relation to the fibre content of milk substitutes. Hay of the best quality will contain as much as 20 to 25 per cent. fibre, whereas cake and mealmixtures can easily be made up to contain only from five to seven per cent. Judging from the use made of hay by calves, it would appear that unnecessary emphasis has been laid on the need for a very low fibre content in milk substitutes. It is also probable, however, that foods with a larger fibre content may safely be given, provided they are given in such a form that they are chewed in the mouth and mixed with the saliva in a natural manner before being swallowed. It may well be the case that where meals are given in the form of gruels, the rapid swallowing of the food without chewing and mixing with saliva prevents the process of digestion proceeding with the same ease and efficiency, hence the proportion of fibre may safely be greater in a milk substitute given as a dry food than in one given as a gruel.

Reference may also be made here to the need or otherwise for a proportion of fat in a milk substitute. Table I shows that the dry mixtures specified contain only about one-fourth to one-sixth of the amount of fat present in one gallon of whole milk, but studies of the process of digestion have proved that the fat in the food is used mainly as a source of heat and energy in the animal body, and also that the fat in the body can be and often is made from carbo-hydrates (starches and sugar) supplied in the foods. It follows, therefore, that a low fat content in a dry milk substitute is not necessarily a serious matter, provided the mixture contains a good proportion of digestible carbo-hydrates and is given in a form which permits free play to the natural processes of digestion.

### Quantity of Whole Milk Allowed.

Groups of calves have been reared in different years with allowances of whole milk per head ranging from 30 gallons to 60 gallons. The daily allowance in every instance was limited to one gallon, hence where 50 to 60 gallons were given the milk was given for a longer period of time.

The results have been grouped together in Table IV and show the average live weights of the different groups of calves when one week old and at the end of each of the next six three-week periods, *i. e.*, up to the age of 18 weeks. The daily live

weight increase for each of the three-week periods is also given as a measure of the rate of growth.

The average live weight at approximately one week is shown to be just over 90 lbs.—all calves were Dairy Shorthorns—and for the first three weeks all groups made practically the same progress, the live weight increase daily being from 0·94 to 1·05 lb. per head. During the second three-week period the calves receiving only 30 gallons new milk were changed over fairly quickly to dry feeding and their live weight increase fell to 0·73 lb. per head daily; those receiving about 40 gallons milk were also having their whole milk allowance reduced, and their live weight increase was at the rate of 1·19 lb. per head daily; the other groups receiving milk for a slightly longer period showed increases from 1·23 to 1·46 lb. per head daily. During the third three-week period the two groups receiving least milk made live weight increases of under 1 lb. per head daily, whereas the other groups showed little change in their rate of growth, although their whole milk allowance was either stopped or reduced to a small amount daily. In the fourth three-week period the first group showed an increased rate of growth whereas the others showed a decrease and there was little change during the fifth period. In the sixth three-week period, however, all groups showed an increased rate of growth, and it is interesting to note that the group receiving least milk made as good progress as any of the others.

The chief point that arises from the above results is whether the rate of growth and general health of the calves receiving the smaller amounts of milk are satisfactory. The writer is of the opinion that in the case of Dairy Shorthorn heifer calves being reared for herd purposes, a live weight increase of 1 lb. per head daily for the first four months is quite satisfactory, provided the feeding in the following months is adequate. A daily live weight increase of 1 lb. can be maintained easily and economically for two years, and, if added to a birth weight of 90 lb., gives a total of 820 lb. or fully 7¼ cwt. at this age.

During the fourth to sixth weeks when the whole milk is being reduced there is a loss of "bloom", but very little check to the rate of growth. The subsequent growth records and general history of the calves which received less than 40 gallons whole milk were perfectly satisfactory, and those which received an additional 10 to 20 gallons showed no corresponding advantage after the age of five to six months.

## Cake and Meal Mixtures Used.

All the mixtures included in Table I with the exception of "A" (linseed cake and crushed oats in equal parts) have been used from time to time with satisfactory results.

The simple mixture of four parts linseed cake, three parts maize meal and one part fish meal was used for one winter season with success, but when used on another occasion some of the calves picked out the linseed cake and left a large part of the meal. In order to make such selection almost impossible, mixtures C, D and E (Table I) were prepared, where a proportion of flaky food such as crushed oats or maize flakes were included along with meals and cake. Other common foods such as barley meal and crushed wheat have been used from time to time in partial replacement of crushed oats and maize meal and bran in place of sharps. A further selection of mixtures is given in the summary at the end of this paper.

### Average Analysis of Dry Mixtures.

Many of the mixtures usually sold and used to take the place of whole milk in calf-feeding do not contain a sufficiency of protein (albuminoids) and are also often deficient in bone forming matter.

The mixtures found to be satisfactory in the above-mentioned experiments and trials contain approximately the following percentages of food constituents :--

| | Total Percentages. | Digestible Percentages. |
|---|---|---|
| Protein | 22 to 25 | 17 to 21 |
| Oil | 5 to 7 | 4 to 6·5 |
| Carbo-hydrates | 44 to 48 | 42 to 45 |
| Fibre | 5 to 7 | |
| Lime | 1 to 1·5 | .... |
| Phosphoric Acid | 1·5 to 1·8 | .... |
| Starch Equivalent | .... | 70 to 74 |

### Cost of Dry Mixtures.

Because of the remarkable decrease in the price of all kinds of concentrates during 1930 it is of little use to quote the prices of the above-mentioned mixtures in earlier years. The main object of including statements of costs is to provide a basis of comparison with other mixtures—either made up on the farm or of proprietary origin—which may be available for the same purpose.

The following are the prices including cost of delivery to the farm at which the different foods mentioned have been bought during the current winter season, and the price per cwt. of two typical mixtures :—

| | s. | d. | | s. | d. |
|---|---|---|---|---|---|
| Linseed Cake—4 cwt. at 9s. 6d. . . | =38 | 0 | 4 cwt. at 9s. 6d. . . | =38 | 0 |
| Crushed Oats—2 cwt. at 7s. . . . | 14 | 0 | 1½ cwt. at 7s. . . . | =10 | 6 |
| Barley Meal—2 cwt. at 7s. . . . | 14 | 0 | . . . . . . . | .. | |
| Sharps—1 cwt. at 6s. 3d. . . . | 6 | 3 | . . . . . . . | .. | |
| Fish Meal—1 cwt. at 20s. 3d. . . . | =20 | 3 | 1 cwt. at 20s. 3d. . . | =20 | 3 |
| Maize Flakes . . . . . . | .. | | 2 cwt. at 8s. . . . | 16 | 0 |
| Locust Bean Meal . . . . . | .. | | 1½ cwt. at 6s. 9d. . . | =10 | 1½ |
| 10 cwt. costs . | 92 | 6 | 10 cwt. costs . | 94 | 10½ |
| 1 cwt. costs . | 9 | 3 | 1 cwt. costs . | 9 | 6 |

When calves have attained the age of five to six months, the fish meal can be reduced or omitted because by that time the proportion of protein can be reduced and more hay will be eaten, thereby supplying additional mineral matter.

### Substitutes for Fish Meal.

On several occasions, farmers who had adopted one or other of the above-mentioned mixtures commented on the high cost of fish meal, and, as fish meal had been satisfactorily replaced by soya bean meal and decorticated groundnut meal and lime in the feeding of pigs it was decided to make a similar attempt with calves.

During the winter of 1928-29 four lots of home-bred Shorthorn heifer calves, consisting of three of about similar age in each lot, were available for this experiment. The lots were made up when the calves were eight to ten weeks old and had already been taught to eat a dry mixture. Two lots were given a fish meal mixture and the other two lots a mixture of practically equivalent analysis in which the fish meal was replaced by extracted soya bean meal with chalk added to make the lime content equal to that of the other mixture. The amount of chalk required was calculated to be $\frac{1}{3}$ ounce $CaCO_3$ per 1 lb. concentrates (approximately 2 per cent.); in practice a moderately heaped table spoonful was added per 2 lb. cake and meal mixture at the time of feeding.

The amount of each mixture given daily ranged from 2½ lb. up to 4 lb. per head, and 4 to 8 lb. of hay per head was also given, with water as required. All the calves ate the mixtures readily.

The results of this experiment are set out in Table V, and it will be evident that both mixtures proved very satisfactory so far as live weight increase was

concerned. As regards general appearance a few observers were of the opinion that the fish meal lots appeared to be doing better, but others could see no appreciable differences.

TABLE V.

*Comparison of Fish Meal and Soya Bean Meal (Ext.) Mixtures.*

| Food. | No. of lot. | Average daily live weight gain from birth to beginning of experiment. | Experimental period. | | |
|---|---|---|---|---|---|
| | | | No. of days. | Live weight gain per head. | Daily live weight gain per head. |
| **Fish Meal Mixture—** | | lb. | | lb. | lb. |
| Linseed Cake . 3 parts. | I | 1·34 | 140 | 213·5 | 1·52 |
| Crushed Oats . 2 „ | | | | | |
| Maize Meal . 2 „ | III | 1·26 | 92 | 138·5 | 1·50 |
| Fish Meal . . 1 part. | | | | | |
| **Soya Bean Meal Mixture—** | | | | | |
| Linseed Cake . 3½ parts. | II | 1·37 | 140 | 213·4 | 1·52 |
| Crushed Oats . 3 „ | | | | | |
| Maize Meal . . 2 „ | | | | | |
| Soya Bean Meal (ext.) . . 1½ „ | IV | 1·26 | 92 | 131·3 | 1·43 |
| Ground Chalk 2 per cent. . | | | | | |

The cost of the two mixtures at the prices then ruling were 12*s*. 6*d*. per cwt. for the fish meal mixture, and 11*s*. 6*d*. per cwt. for the soya bean meal mixture. At current prices the corresponding figures would be slightly under 9*s*. 6*d*. and 8*s*. 6*d*. per cwt. respectively. This difference in price is less than would be expected, but it must be remembered that fish meal, although costly, constitutes only one-tenth of the mixture. The actual saving in feeding by the use of the soya bean meal mixture amounted to 1*s*. per calf per month, which would represent about 4*s*. to 6*s*. per calf reared during the winter period. Against this must be placed the extra time required for the measuring of the right amount of chalk, and mixing it into the dry foods.

## Dried Separated Milk as a Milk Substitute.

More recently experiments have been instituted to determine the possibility of replacing part of the whole milk by dried separated milk. One lot of four calves has been reared on a milk allowance of slightly over 40 gallons per head, and another lot of four calves has received exactly 20 gallons of whole milk per head spread over the first 35 days and from the 15th day, dried separated milk, reconstituted at the rate of 1 lb. dried milk to 1 gallon water with one ounce of cod liver oil per pound of dried milk, has been given in gradually increasing amounts. The total weight of milk powder given was 25 lb. between the 15th and 49th day, after which only dry foods (Mixture E., Table I), hay and water have been given. So far the results are quite satisfactory; the average live weight gains of the respective lots up to the age of nine weeks have been 1·21 lb. and 1·04 lb. per head daily.

The saving which may be made by the use of dried separated milk used on the above lines is considerable. In this experiment 20 gallons whole milk have been replaced by 25 lb. dried separated milk. If the former be valued at 1*s.* 5*d.* per gallon and the dried separated milk at 4*d.* per lb., the saving is equal to 20*s.* per calf; if the whole milk is valued at 1*s.* per gallon, the saving is 11*s.* 8*d.* per calf. Further experiments to confirm or modify the above results will be carried out as opportunity offers.

I have much pleasure in acknowledging the valuable assistance of Messrs. W. B. Morris, B.Sc., P. T. Joyce, B.A., J. E. Rowe and F. Phillips in the experimental work described in the foregoing pages.

## Summary.

During the first three to four days of the calf's life it should get its own mother's milk, then it should get about four quarts whole milk for about four weeks. Calves begin to chew the cud about the fourth week, and hay and dry foods can then be given, commencing with a handful of meal mixture in the bottom of the milk pail twice daily during the fourth week; increase the allowance the next week, giving it twice daily in a clean pail or trough, and reduce the milk, adding water to give sufficient liquid.

During the fifth to the eighth weeks the whole milk can be gradually reduced and the dry mixture increased. After the eighth week no milk need be given and the diet thereafter consists of dry meal mixture, good hay and water; in cold weather warm the water slightly.

*Time Table of changes in diet.*

| | |
|---|---|
| First to third weeks | Whole milk 4 qt. daily in two feeds. |
| Fourth week | Whole milk 4 qt., meal mixture ¼ lb., daily. |
| Fifth week | Whole milk 3 qt., water 2 qt., meal mixture ¼—½ lb., daily. |
| Sixth week | Whole milk 2 qt., water 3 qt., meal mixture ½—¾ lb., daily. |
| Seventh week | Whole milk 2 qt., water 3—4 qt., meal mixture ¾—1 lb., daily. |
| Eighth week | Whole milk 1 qt., water 4—5 qt., meal mixture 1—1½ lb., daily. |
| Ninth week and afterwards | Meal mixture 1—3 lb., water as needed daily. |

Hay to be increased as needed from the fourth week.

Increase the dry meal allowance (given in two feeds daily) as rapidly as the calves will take it, up to 3 lb., per head daily, with all the good hay they will eat for the normal rearing of heifer calves. When more rapid growth and better condition is wanted give a little more milk and up to 4 lb. meal mixture. Fish meal can be omitted after the fifth month.

*Dry Meal and Cake Mixtures.*—A general formula is :—Linseed cake, 30—40 per cent. ; white fish meal, 10·5 per cent. ; starchy meals and grains, 40—60 per cent., and at least half of the starchy foods (or 20—30 per cent., of the mixture) should be in a bulky flaky form.

*Typical mixtures* which have given good results are :—

| | | Per cent. |
|---|---|---|
| I. | Linseed cake (broken) | 30 |
| | Fish meal | 10 |
| | Oats (crushed) | 40 |
| | Maize meal | 20 |
| II. | Linseed cake (broken) | 40 |
| | Fish meal | 10 |
| | Oats (crushed) | 30 |
| | Barley meal | 20 |
| III. | Linseed cake (broken) | 40 |
| | Fish meal | 5 |
| | Oats (crushed) | 20 |
| | Flaked maize | 20 |
| | Sharps | 15 |
| IV. | Linseed cake (broken) | 30 |
| | Fish meal | 5 |
| | Bean meal | 20 |
| | Oats or barley (crushed) | 25 |
| | Flaked maize | 20 |

The cost of a dry meal mixture should be slightly less than linseed cake. The amount of food for the first six months will be about 35—40 gallons whole milk, 3—3½ cwt. cake and meals and 5—6 cwt. good hay.

# SOIL SURVEYS

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NOTICES of soil surveys carried out in different parts of the country have appeared from time to time in this JOURNAL. During recent years, however, considerable changes have taken place in methods of classification and mapping. These changes are due partly to contact with foreign workers, but also, in a great degree, to the increase in the amount of survey work in this country made possible by special grants from the Ministry for work in certain advisory provinces. It may, therefore, be of interest to give an account of the principles underlying modern soil surveys and to describe the methods actually in use.

In the earliest soil surveys carried out in this country, the basis of classification and mapping was purely geological. On the assumption that each geological formation, due regard being paid to lithological variations, gave rise to its own type of soil, the survey consisted mainly in the collection and examination of typical soils from each outcrop. The surface geological map could thus, with interpretation, serve also as the soil map. This method of survey, whilst generally valid for the conditions of south-eastern England, as exemplified by the work of Hall and Russell in Kent, Surrey and Sussex, did not prove equally applicable to other parts of the country. In the first place, over most of Great Britain north of the Thames there are extensive spreads of glacial and other superficial deposits. These vary in thickness and, to complicate the task of the soil surveyor still further, are often of variable and uncertain origin. The term boulder clay may itself lead to much confusion, since it embraces a wide range of textural grades from clay to sand. Secondly, climate, topography, altitude, drainage, and other circumstances may result in very different soils being formed from the same parent material. Indeed, it has been found in extreme cases that the effect of geology may be almost obliterated by the operation of the soil-forming processes, with the result that similar soils may be formed from different parent material.

The experience of soil survey workers, notably those in Russia and the United States, has taught us that, in studying the field relationships of soils, the only

satisfactory basis of classification is that furnished by the actual properties of the soil itself, and that the proper unit of study is the complete soil profile.

The soil profile is the succession of horizons from the surface soil down to the parent material, which may be solid rock, glacial drift, or any material from which soil is formed. The character of the soil profile reflects both the nature of the soil-forming processes and also the effect of the parent material on which they have operated. It may be modified by cultivation, with the result that profiles of agricultural soils differ considerably from those of the virgin soils from which they have been reclaimed. The soil profile, preferably studied on virgin soils, is the basis for the natural classification of soils and the great world groups are distinguished by characteristic profiles.

The processes which lead to the differentiation of soils into horizons are mainly connected with the movements of water in the soil. These movements are governed by the relative intensity of rainfall and evaporation. In arid climates, where evaporation predominates over rainfall, the tendency is for soluble salts to accumulate at or near the surface. In semi-arid climates, where the leaching action of the rainfall is more pronounced, the soil profile is characterized by the accumulation of an horizon of calcium carbonate, often accompanied by calcium sulphate. The depth at which this horizon occurs increases with the intensity of the leaching.

In humid climates, rainfall predominates over evaporation and the soil profile is subjected to leaching down to the water table. There is thus a complete washing out of soluble salts and also of calcium carbonate, with the consequent development of acid conditions. The complete expression of this type of soil formation in cool climates is seen in the so-called *podsol* profile (*see* Fig. 1), developed under cover of heath or coniferous forest vegetation. In the podsol profile, the essential horizons are, beginning from the surface, $A_0$, a layer of peaty material; $A_1$, a layer of bleached greyish or even white material from which iron and aluminium oxides have been removed by leaching; B, a brown or reddish-brown horizon enriched by the deposition of iron and aluminium oxides leached from the A horizons; and C, the parent material. In the most extreme podsol types, there is also a leaching out and deposition of humic matter, with the result that the B horizon is black or dark brown in colour. Among the best examples of podsol profiles in England are those found on the Bagshot Sands of Surrey. Elsewhere in England, the differentiation into horizons is generally less pronounced, except on areas of light sandy soils in heaths. This is due partly to the fact that, except on very light soils, the leaching processes are not sufficiently intense for the development of good profiles, and partly to the effect of long continued cultivation

which tends to mix up the soil horizons and also to counteract the extreme acidity which is requisite for podsol formation.

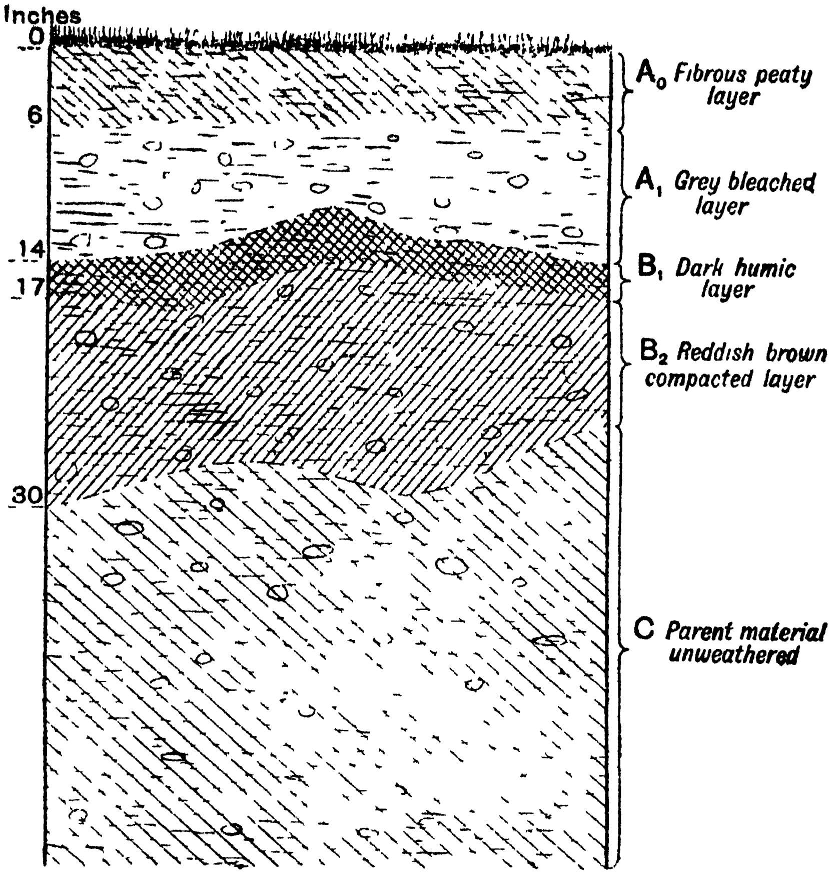


FIG. 1.—A PODSOL PROFILE.

Profile development in some cases leads to the formation of an impervious pan, which not only interferes with water movements, but also restricts root development. Pans may be due to the effect of the mechanical washing down of the finer particles from the surface soil, or the processes of solution and deposition such as occur in the formation of podsol profiles. In some cases, a combination of these two types of differentiation may occur. In any case, the occurrence of layers of varying mechanical and chemical composition exerts a profound influence on the conditions of plant growth in the soil and is, therefore, of importance in agricultural practice. The conclusions drawn from this method of study are evidently more valid and of wider application than those derived from the study of

samples of soil and subsoil as in the earlier surveys, and may be expected to furnish suggestions as to the probable behaviour of soils under cultivation and cropping.

Those engaged in survey work in this country have for some years met periodically to discuss methods and to compare experience. They have also received much assistance from the Geological Survey, and most soil surveyors have had the opportunity of becoming acquainted with the methods of geological mapping. Although certain details remain to be adjusted, substantial agreement has now been reached regarding the lines on which soil survey work shall proceed in the future. In this connexion, it may be mentioned that soil surveyors are greatly indebted to the helpful counsel of Professor Linwood L. Lee, of New Jersey, who spent a year in this country and visited all the centres at which soil surveys were being carried out.*

It has been generally agreed that soil mapping shall be carried out with the six-inch Ordnance Survey maps as base maps. Agreement has been reached as to the data to be recorded on such maps in the field. The object in view is to secure that, in the actual mapping, all data of agricultural importance, as far as they can be ascertained, shall be recorded. These data refer to (1) surface ; (2) stoniness ; (3) texture ; (4) colour ; (5) water conditions ; and (6) the nature of the soil profile succession. In addition, notes as to natural vegetation are recorded where possible. Appropriate symbols are used for the purpose of setting out the observed data on the maps. For example, in the case of texture, S stands for sand, Sa for light sand, Sb for sandy loam, L for loam, La for light loam, Lb for heavy loam, and so on. A complete description might be set out as

(1) $\dfrac{\text{Lb. Bg. } \beta}{\text{4. C.G.}}$ This would signify a moderately-stony, greyish-brown heavy loam overlying a grey deep drift clay and subject to seasonal wetness. The data as to surface are recorded by means of arrows pointing down the slopes with differences to indicate degrees of steepness. An example of a soil map is shown in Fig. 2.

A complete record field by field, supported by analyses of typical soils, should give all the necessary soil data for agricultural purposes. It is desirable, however, to arrive at some system of classification in order to throw into relief the relationships of soils to each other, and to secure a readier presentation and generalization of the data obtained. It has been generally agreed among surveyors that a system based on that in use by the United States Soil Survey shall be used. The principal members in this system of soil classification are the soil

*Professor Lee also contributed to this JOURNAL an article on *Soil Surveys and their Utilization*, October, 1930, p. 653.

*series.* A soil series is a set of soils derived from the same or similar parent material under similar conditions of climate, topography, and drainage, and showing the same general profile characteristics. Series are named after the localities in which they are first studied or where they attain a considerable development. The Powys series, recognized in the soil survey of Wales, may serve as an example. Soils of this series are derived as sedentary soils under conditions of free drainage from non-calcareous shales, flagstones, and mudstones of Cambrian Ordovician and Silurian age. The profile consists of a brown or buff-brown shaly loam overlying a lighter brown or yellowish-brown subsoil of heavier texture. Variations in texture give such types as the Powys light loam, the Powys silty loam, the Powys heavy loam, and so on. It should be noted that, although the series are described in terms of geological parent material and mode of formation, the actual criteria for recognition are the characters of the profile. If, therefore, the same profile is given by soils derived from different parent material, there would be good reason for grouping them in the same series. For example, in the Welsh soil survey, there does not appear to be any real difference between the Bangor series derived from acid and intermediate igneous and pyroclastic rocks, and the Anglesey series derived under similar conditions from pre-Cambrian schist. If fuller study should confirm this impression the two series would be united into a single series. The Glamorgan series includes soils derived from Lower Lias limestones and also soils derived fiom Rhaetic beds.

For convenience of grouping, series derived from the same parent material may be considered as forming a *suite.* For example, the Powys suite consists of all soils derived from non-calcareous shales, flagstones and mudstones of Cambrian, Ordovician and Silurian age. Varying conditions of formation distinguish the different series. The Powys series comprises the sedentary soils with free drainage, the Penrhyn series, the drift and hillwash soils with free drainage, the Cegin series, the drift soils with impeded drainage, and the Conway series, the alluvial and bottom soils. Other series of the same suite may be isolated on the basis of topography.

The advantage of arranging soils into series, as has been described, is that soils having the same general mineralogical and chemical composition, similar topography, and similar behaviour in respect to water conditions, are grouped together. When due allowance is made for climatic influnces, it is reasonable to suppose that soils of the same series will be similar in agricultural behaviour and potentialities. The success of the classification into series will be reflected in the extent to which it tallies with the known agricultural characters of the soils classified.

The methods and instances described in the present account are taken from the soil survey of Wales and differ in some details from those applicable to other areas. A small committee set up by the Ministry is now attempting to correlate the soil survey work in different advisory provinces. For this purpore, a careful examination is made of the principal series recognized by individual surveyors in order to decide to what extent they can be identified with each other. If, for example, Series A in Area X proves to be identical with Series B in Area Y, and with Series C in Area Z, then, in future work, Series A, B and C may be considered as one series and mapped as such.

The principal use of the soil survey is as a basis for advisory work. An isolated inquiry, even when accompanied by a sample of soil for analysis, can rarely be answered satisfactorily unless a comprehensive view of local circumstances is possible. This can, of course, be most satisfactorily secured by a personal visit, but a reliable soil map carrying the kind of information indicated in the present article places the adviser in possession of most of the information which would be obtained by an actual visit. Further, a knowledge of the characteristics of the principal soil types of an area will enable the adviser to recognize abnormalities in individual soils.

The soil map should form the basis for field experimental work. Too often in the past, such experiments have been located on unrepresentative soils, whilst it has even happened that an experiment has been spread over more than one kind of soil. Adequately replicated plot trials are costly to carry out, and it is highly desirable to ensure that their significance should be as wide as possible. When the soil survey of a province has been completed, it will be possible to decide which are the most important soil series and to arrange for the laying out of experiments in the most advantageous localities.

The information acquired from the soil survey, and from the analysis of the soil samples taken, will generally result in a more accurate knowledge of the manurial requirements of different types of soil. The case of soil sourness suggests itself. There are, undoubtedly, large areas in urgent need of liming, and a soil survey might be expected to indicate the location and extent of such areas and to serve as a basis for the necessary propaganda. At present, even where a large proportion of the area of a district is known to be in need of lime, no widespread recommendation can be made until the distribution of the sour lands is known with reasonable precision.

From time to time there is considerable discussion, often among those least informed, of the possibilities of land reclamation. Whilst most of the waste lands are uncultivated on account of their inherent unsuitability for agriculture, there

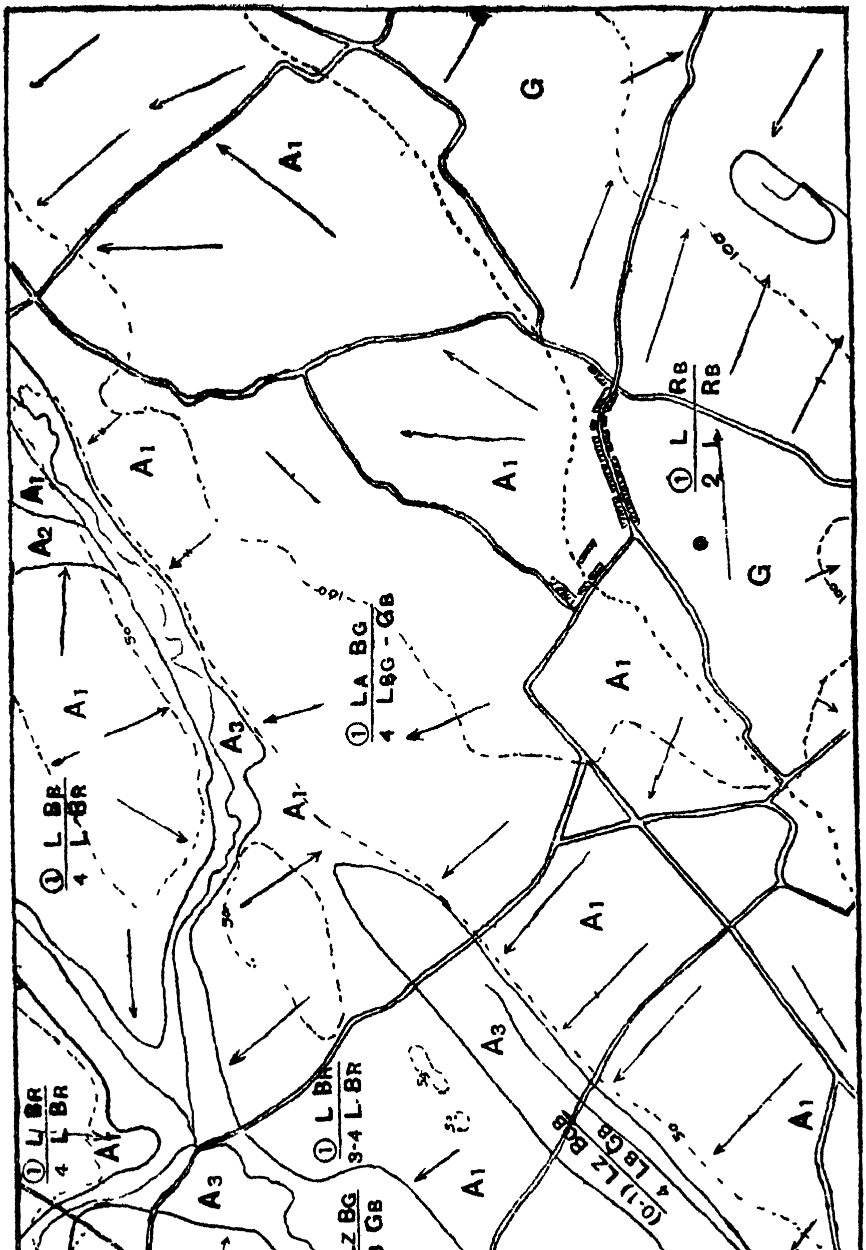


FIG. 2.—PORTION OF SOIL MAP OF ANGLESEY. XXII. N.E.

*Series.*—$A_1$. Gaerwen loam to light loam; deep, well-drained soils derived from metamorphic schists. $A_2$. Gesail heavy loam: soils derived from schistose material with impeded drainage. $A_3$. Braint silty loam; alluvial soils from schistose material. G. Gower loam; rather shallow, well-drained soils from carboniferous limestone. The arrows point down slopes.

are large areas of wet land which might be worth improvement, particularly as such lands are generally rich in plant food and only require the proper regulation of their water economy. A soil map would give the necessary information as to the areas most likely to repay for expenditure on drainage, and would show the relationship of the wet lands to the general drainage system of the district, thus facilitating the institution of comprehensive schemes of arterial drainage.

There is another aspect of soil survey work, which, however, mainly concerns suburban districts, namely, its bearing on schemes for housing development. A knowledge of the nature of the soil and, in particular, its drainage conditions, would be of great value in determining the value of particular tracts of land for housing schemes. It is obvious that such schemes should not be developed on areas characterized by impeded drainage conditions.

# THE CALCIUM AND PHOSPHORUS SUPPLY OF DAIRY COWS.*

BY

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A vast amount of scientific research has been undertaken in many parts of the world in recent years concerning the mineral requirements of cattle, and while this paper was in the course of preparation an exhaustive review of the relevant literature was published by J. A. Crichton[1] in the *Journal of Dairy Research.* The present communication may be said to take up the information thus presented and to attempt to show to what extent ordinary unsupplemented rations may be expected to meet the milch cow's requirements for calcium and phosphorus. No other mineral constituents are considered.

Many writers have drawn attention to the difference between the modern dairy cow and a cow leading a natural life grazing at large on suitable food. Under natural conditions a cow would secrete approximately 200 gallons of milk for the sustenance of a calf, and her food, the only natural food of herbivorous animals, would be grass and other plants which would be in their most nutritious state during the normal period of maximum milk yield. The modern cow is not considered to be of much value unless she can produce at least four times the quantity of milk she was intended by nature to produce. She is required to breed at any seasonal period, and her capacity for reaching maturity at an early age has been increased. Her food for the most part is unnatural and often unsuitable for the purpose intended. Added to these there are other burdens of domesticity among which may be mentioned, in particular, bad housing with lack of exercise and sunlight, and not infrequently an inadequate water-supply.

The present-day dairy cow has indeed had surprising things done to her; that she survives and manages to keep in fair health is a tribute to the extraordinary adaptability of animals to conditions far different from those Nature intended. It is important to keep in mind that the high-producing cow was evolved, by a process of selective breeding, in advance of knowledge concerning her food requirements. It is true that quantitatively, in terms of total nutriment consisting of protein, fat and carbohydrate, the cow's needs have been more carefully studied and, one is justified in thinking, adequately met. Indeed,

* Presented at the 49th Annual Congress of the National Veterinary Medical Association of Great Britain and Ireland, August 22nd 28th, 1931.

Halnan[2] has recently published a critical study which suggests that so far as the above-mentioned constituents are concerned, feeding for maintenance has been on the liberal side. On the other hand, it is only within comparatively recent years that serious attention has been focussed on the needs of the animal for the mineral constituents drained from the body into the milk. What this outflow amounts to is easily determined, but what its real significance is in relation to the health and well-being of high-yielding cows is not by any means clear, and it is advisable for us to consider this matter carefully in view of the fact that our advice is so frequently sought regarding the supply of calcium in the food. The illuminating work of Little and Wright[3] and Dryerre and Greig[4] has naturally added interest, and perhaps importance, to this aspect of bovine nutrition, but between the discovery of a serum-calcium deficiency in milk fever cases and the establishment of a dietetic cause, there is a gulf yet to be bridged.

Since the primary object of this communication is to open a discussion on the requirements of calcium and phosphorus by the dairy cow, it becomes necessary, in the first instance, to state briefly the "feeding standard" upon which the diets later to be discussed are based.

In order to avoid complexity in the following discussion the diets considered are based on the requirements for a 1,000-lb. cow (an Ayrshire) secreting milk containing 3·5 per cent. of butter-fat. The feeding standard for such a cow, which has been accepted for many years as being satisfactory, is Starch Equivalent 6-lb. and Protein Equivalent 0·6-lb. for maintenance, with an additional 2·5-lbs. of S. E. and 0·6-lb. P. E. per 10-lb. (1 gallon) of milk. Halnan in his new survey of maintenance requirements suggests a standard of S. E. 5-lb. and 0·6-lb. P.E., and for milk (3·5 per cent. butter-fat), S. E. 2·3-lb. and P. E. ·54-lb. per gallon. For the purpose of this paper Halnan's standard has been adopted, and accordingly the food requirements of an Ayrshire cow would be for maintenance and milk :—

| | S.E. lbs. | P.E. lbs. |
|---|---|---|
| Maintenance and 1 gallon | 7·3 | 1·14 |
| „ 2 gallons | 9·6 | 1·68 |
| „ 3 „ | 11·9 | 2·22 |
| „ 4 „ | 14·2 | 2·76 |
| „ 5 „ | 16·5 | 3·30 |

The total dry matter in these diets should fall somewhere between 25 and 30 lbs.

The food requirements in terms of energy, protein and "bulk" having been defined, there remain to be considered the cow's requirements of calcium and phosphorus and the extent to which these would be met in ordinary unsupplemented diets based on the above standard. Notwithstanding the intensive work

that has been carried out during recent years, there still remains a considerable element of doubt regarding the needs of the milch cow for calcium and phosphorus, both for the maintenance of her body and for milk secretion.

This is understandable in view of the great difficulties involved in carrying out mineral metabolism experiments with cattle over sufficiently long periods. Furthermore, the factors which influence mineral assimilation are in themselves complex, not fully understood, and not necessarily of geographical or even seasonal uniformity. According to Henneberg (quoted by Crichton) whose figures are adopted by Kellner[5] a 1,000-lb. cow requires for maintenance 32·5 gm. calcium (Ca) and 10 gm. phosphorus (P) daily and this estimate is adopted for the purpose of the following argument.

Whatever may be the margin or error in this conclusion, it can be but small compared with the difference of opinion concerning the requirements for milk yield.

The amount of calcium and phosphorus secreted in any quantity of milk can easily be determined since we know that milk contains 0·118 per cent. of calcium (Ca) and 0·10 per cent. of phosphorus (P) (Rowett Research Institute averages are, CaO 0·166 and $P_2O_5$ 0·229 per cent.). Thus the amounts secreted are :—

| | Ca | P |
|---|---|---|
| 1 gallon | 5·38 g. | 4·5 g. |
| 2 gallons | 10·76 g. | 9·0 g. |
| 3 ,, | 16·14 g. | 13·5 g. |
| 4 ,, | 21·52 g. | 18·0 g. |
| 5 ,, | 26·90 g. | 22·5 g. |

But the amount of these minerals secreted in the milk is of itself no indication of the amount required in the food. Clearly, the requirements of both calcium and phosphorus could not be met by giving in the food similar quantities to those excreted *via* the milk since the percentage assimilation and utilisation could not under the most favourable conditions approach 100 per cent.

It is here that the difficulty arises of supplying an accurate and adequate answer to the query so frequently put to the dietist :—Is it necessary to add calcium to the diet of a milking cow and if so, in what quantity? Assuming the above-mentioned maintenance requirements to be correct, an answer to the question would be available could the percentage assimilation of food calcium and phosphorus be determined. But it is here that difference of opinion and difference in experimental results are apparent. It would be well at this juncture to quote from Crichton's paper :—

"It is not the amount ingested in the food that matters, but the amount absorbed. On an ordinary ration an assimilation of 15 to 20 per cent. of the mineral matter may be expected, Miller *et al*[8] consider that 'the alimentary absorption of calcium and phosphorus is controlled to a certain extent by the demands of the animal.' They found the percentage utilisation of calcium to be highest at the height of lactation, but even then it does not exceed 23 per cent. According to Meigs *et al*[9] this is not exceeded even in well-cured fodder. Hence a calculation of maintenance requirement, plus the calcium in the milk, does not truly represent the total requirement. A margin of safety of several times the calcium in the milk appears to be required to maintain equilibrium. If 15 to 20 per cent. be taken as an average assimilation, there are very few rations which, unsupplemented, would provide sufficient calcium."

At the conclusion of his paper Crichton says: "The making good of gross mineral deficiencies in the rations of cows, by the addition of mineral salts, involves no great difficulty. It is a simple matter to compute the approximate mineral content of the ration from available analytical data. A comparison of the percentages of each of the minerals present and of the ratios of these amounts to the percentage amount of protein or to the energy value of the ration, with those found in either milk or good pasture, will show whether, and roughly, to what extent, any of the minerals is deficient."

But Crichton does not say what the calcium and phosphorus requirements of the cow in milk are.

It has not been proven that the quantities of calcium or phosphorus ingested by a cow from good well-grazed pasture represent the necessary minima. If the basis of assessment be the amount secreted in the milk, is the assumption correct that only 20 per cent. of the food calcium is assimilated ? Assuming this to be so, then the requirements for a 1,000-lb. cow would be:—

| | Ca | P |
|---|---|---|
| Maintenance, plus 1 gallon . . . . . . . . . . | 59·4 g. | 32·5 g. |
| " " 2 gallons . . . . . . . . . . | 86·3 g. | 55·0 g. |
| " " 3 " . . . . . . . . . . | 113·2 g. | 77·5 g. |
| " " 4 " . . . . . . . . . . | 140·1 g. | 100·0 g. |
| " " 5 " . . . . . . . . . . | 167·0 g. | 122·5 g. |

Needless to say, these quantities of calcium and phosphorus are never remotely approached under ordinary conditions of winter feeding. Kellner's standard,[5] which is 0·87 g. Ca and 0·7 g. P per lb. of milk in addition to 32·5 g. Ca and 10 g. P per 1,000-lb. live weight, indicates a much lower requirement, and if these quantities for milk secretion suffice, they imply a utilisation of 62 per cent.

of the food calcium and 64 per cent. of the phosphorus. Based on Kellner's standard the requirements per gallon of milk are :—

| | Ca | P |
|---|---|---|
| Maintenance, plus 1 gallon | 41·2 g. | 17 g. |
| „ „ 2 gallons | 49·9 g. | 24 g. |
| „ „ 3 „ | 58·6 g. | 31 g. |
| „ „ 4 „ | 67·3 g. | 38 g. |
| „ „ 5 „ | 76·0 g. | 45 g. |

According to this, therefore, approximately one-third of both calcium and phosphorus is required in the food, to make good that lost in the milk, compared with that amount which would be needed were the utilisation only 20 per cent.—needless to say, a very material difference! It should perhaps be noted here that Lindsay and Archibald[7] interpret Kellner's standard per lb. of milk, in addition to the maintenance standard, as 0·8 g. Ca and 0·5 g. P ; on this assumption, therefore, the requirements would be even lower than those stated above.

With such a wide difference between two suggested mineral needs it is of importance to consider what evidence there is in support of the view that the lower standard may be adequate, at least for moderately heavy milkers.

Two papers having an important bearing on this have been published recently. Huffman, Robinson and Winter[8] have shown that cows receiving a ration of timothy hay, maize silage and grain, without any mineral supplement, received sufficient calcium and phosphorus for the production of at least 10,000-lbs. of milk a year. They found a negative calcium balance to be the rule during the height of lactation with heavy production, but with medium production, and when dry, sufficient calcium was stored to compensate for the loss. Contrary to the experience of others who have stated that the average utilisation of calcium from well-cured hay is about 20 per cent. of the intake (Meigs, Turner, Harding, Hartman and Grant[9]), Hoffman *et al* found that with their cows on the diet above detailed (a ration poor in calcium, the hay containing 0·30 per cent. Ca) the percentage utilisation ranged from 34·2 to 57·6 per cent. of the calcium ingested (there was one exception). Approximately the same results were obtained for phosphorus. Within the limits of this paper it is not possible to refer in detail to the calcium and phosphorus intake and balance of the experimental cows, but the results are such as to indicate that the need for calcium by a heavy-milking cow may, perhaps, be even less than that suggested by Kellner.

Support is given to the opinions of Hoffman and his co-workers by Lindsay and Archibald[7] who, in a final report on a six-and-a-half-years' investigation on the feeding of mineral supplement to dairy cows, conclude that where the cows are average producers (5,000 to 8,000 lb.) and where they are fed on good quality

roughage, a mineral supplement is not indicated. For heavy producers (10,000-lbs. and upwards) they say that it is probably good insurance to supply supplemental lime and phosphorus, but "the efficacy of such a practice is by no means well established." These investigators express the opinion that the problem of mineral deficiency in rations is largely a regional one, and that where the roughage carries a reasonably high percentage of calcium and liberal grain feeding is practised, mineral supplements will not be necessary for the average cow. Concerning Kellner's standard in regard to calcium, they say his minimum would seem to be well above the danger line and also that when cows are grain-fed the phosphorus received is well above the minimum prescribed.

For the purpose of illustrating the actual amount of calcium and phosphorus supplied in ordinary unsupplemented winter diets, three rations have been construed for a cow giving four gallons of milk daily. The diets are such that they meet the requirements, according to the previously stated standard, for energy and protein; the total dry matter falls between 2½ and 3 per cent. of the live weight (1,000 lbs.). In ration A, 15 lbs. of good quality hay is used containing 0·70 per cent. calcium and 0·27 per cent. phosphorus (on 10 per cent. moisture basis). In ration B, the same quality of hay is used but 10 lbs. of oat straw are substituted for ten pounds of the hay; the deficiency in energy and protein thus produced is corrected by increasing the palm kernel cake. In ration C, 15 lbs. Italian rye grass hay, which was found to contain 0·33 per cent. calcium and 0·13 per cent. phosphorus (10 per cent. moisture basis), is substituted for the better grade roughage.

It will be seen that in the case of the good hay the cow would have a negative calcium balance of only —0·3 g. daily while secreting four gallons of milk, *provided that Kellner's standard is correct and that the factors influencing calcium assimilation are favourable.* In ration B, where oat straw is used, the deficiency is increased to —21 g. and in the case of poor grade (forced) rye grass hay the deficiency is as much as — 28 g.

It will, of course, be appreciated that if the factors which are essential for a good assimilation and utilisation of the food calcium are lacking, the deficiency in each case would be very much greater.

Three rations fed to dairy cows in the Liverpool area, the details of which were kindly supplied by Mr. H. T. Matthews, B.SC., F.R.C.V.S., were found to have a tentative calcium deficiency of —38, —31 and —26 g. daily, on the assumption that the hay contained a uniform 0·35 per cent. Ca. The total nutriment in the diets was sufficient for 5, 4·5 and 4·5 gallons of milk respectively. The Ca/P ratios

were ·86, ·72 and ·76. The use of hay containing 0·70 per cent. Ca instead of 0·35 per cent. would alter the calcium balances to −22, −7 and +3 g., the quantities of hay used in these byres: 10, 15 and 20 lbs. respectively, being kept the same. The Ca/P ratio would, of course, be materially altered.

These examples of diets are sufficient to show the importance of utilising hay containing a reasonably high percentage of calcium for the feeding of dairy cows, as the selection of good roughage, the main source of diet in a cow's winter diet, must be of prime importance in assisting the heavy-yielding cow maintain a positive balance, or at least to reduce the extent of loss during the height of her lactation. In order to show to what extent hays vary in regard to the amount of calcium and phosphorus they contain, 41 samples were analysed.

The results are tabulated as calcium oxide and phosphoric acid on dry matter basis and also as calcium (Ca) and phosphorus (P) brought to a uniform 10 per cent. moisture content in the hays. They show a range from 0·32 (a sample of timothy and cocksfoot, the cocksfoot being over-ripe) to 2·30 per cent. for calcium oxide with a mean value of 0·99 per cent.; for the phosphoric acid the range was from 0·29 to 0·75 per cent. with a mean value of 0·46 per cent. These values should not be regarded as average figures for hay since they are to a certain extent regional and the number analysed is insufficient. As Woodman and Evans say[10], it is not easy to decide what is a reanonable figure for the lime content of average meadow hay, since the amount is influenced by the proportion of clover in the sample. They believe, however, that meadow hay should have a higher value than one per cent. of the dry matter. Much of the hay that is fed to cows has a lower value than this. Woodman and Evans quote Klimmer and Schmidt's (1906)[11] summary of data which gives a range of values from 0·95 to 1·60 per cent. for calcium oxide in normal hay, with a mean of 1·20 per cent. of the dry matter, and a range from 0·42 to 0·81 per cent. for phosphoric acid with a mean value of 0·53 per cent. in the same hays. Klimmer (1920) also gives average values of calcium oxide and phosphoric acid for many varieties of hay in his text-book[12]. In hay from non-legumes the range of CaO on dry matter basis is 0·05 to 1·15 per cent. and for $P_2O_5$ 0·16 to 1·07 per cent. (lowest values from sour grasses, reeds, etc.) For legume hays the range of CaO is given as from 0·64 to 3·17 per cent. and for the $P_2O_5$ from 0·41 to 1·15 per cent. .

But while a liberal supply of calcium in the diet is the first need, the factors which together ultimately control its utilisation are not of lesser importance. If the percentage availability may range, according to experimental returns, from 5 to 50 per cent. or even greater, the dietist will indeed be in a quandary when he is set the task of giving advice as to the addition of calcium to diets. The

factors which affect assimilation are as yet but little understood ; they include the complex actions and inter-actions of the vitamins in the food, the action of sunlight, environmental conditions, exercise, water-supply, and the calcium/phosphorus ratio in the diet. The ratio of calcium to phosphorus in diets has attracted a deal of attention from investigators, and while suggestions have been made as to the optimum proportions in which these minerals should be given, the information appears at present to be too vague for practical application. It may be of great importance in the event of low calcium or phosporus intakes or where the differences between calcium and phosphorus intakes are wide, but Hoffman and his co-workers concluded that the ratio is of much less importance than the total intake. Clearly, any material change in the nature of the food will alter the Ca/P ratio and this is particularly true with hay, the main supply of calcium. Indeed the dietist would find great difficulty in making fine adjustments in the event of future research making it clear that, where the animal is given a luxus consumption of both calcium and phosphorus, the ratio between them is of real importance.

Nevertheless, a sufficient supply of all the necessary minerals must be of importance inasmuch as a deficiency of one will cause a drain from the bones to

*Diet "A" for Ayrshire Cow (1,000 lbs.) Giving Four Gallons per Day.*

| Food. | | S.E. | P.E. | Dry Matter | Ca | P |
|---|---|---|---|---|---|---|
| | lbs. | lbs. | lbs. | lbs. | Gram | mes. |
| Meadow Hay (No. 41) . . . | 15·0 | 4·65 | ·68 | 12·9 | 47·63 | 18·30 |
| Turnips . . . . . | 30·0 | 1·20 | ·12 | 2·7 | 6·81 | 5·43 |
| Oats . . . . . . | 4·0 | 2·48 | ·30 | 3·5 | 1·92 | 10·16 |
| Dec. Grd. Nut Cake . . | ·5 | ·35 | ·21 | ·45 | ·32 | 1·56 |
| Pea Meal . . . . . | 3·0 | 2·16 | ·54 | 2·60 | 1·09 | 5·85 |
| Linseed Cake . . . . | 2·5 | 1·80 | ·61 | 2·20 | 3·97 | 8·73 |
| Palm Kernel Cake . . | 2·0 | 1·50 | ·31 | 1·78 | 2·36 | 4·26 |
| Total in ration . | .. | 14·14 | 2·77 | 26·13 | 64·10 | 54·29 |
| "Standard" requirements . | .. | 14·20 | 2·76 | 25—30 | 67·30 | 38·00 |
| Difference— | | | | | —3·20 | +16·29 |

Ca/P ratio :—1·18.

*Diet "B" for Ayrshire Cow (1,000 lbs.) Giving Four Gallons per Day.*

| Food | | S.E. | P.E. | Dry Matter | Ca | P |
|---|---|---|---|---|---|---|
| | lbs. | lbs. | lbs. | lbs. | Grammes. | |
| Meadow Hay (41) | 5 | 1·55 | ·23 | 4·3 | 15·78 | 6·10 |
| Oat Straw | 10 | 1·70 | ·10 | 8·6 | 11·34 | 4·87 |
| Turnips | 30 | 1·20 | ·12 | 2·7 | 6·81 | 5·43 |
| Oats | 4 | 2·48 | ·30 | 3·5 | 1·92 | 10·16 |
| Dec. Grd. Nut Cake | ·5 | ·35 | ·21 | ·45 | ·32 | 1·56 |
| Pea Meal | 3 | 2·16 | ·54 | 2·60 | 1·09 | 5·85 |
| Linseed Cake | 2·5 | 1·80 | ·61 | 2·20 | 3·97 | 8·73 |
| Palm Kernel Cake | 4 | 3·00 | ·62 | 3·56 | 4·72 | 8·52 |
| Total in ration | .. | 14·24 | 2·73 | 27·91 | 46·04 | 51·22 |
| "Standard" requirements | .. | 14·20 | 2·76 | 25·30 | 67·30 | 38·00 |
| Difference— | | | | | —21·26 | +13·22 |

Ca/P ratio:—·9.

*Diet "C" for Ayrshire Cow (1,000 lbs.) Giving Four Gallons per Day.*

| Food | | S.E. | P.E. | Dry Matter | Ca | P |
|---|---|---|---|---|---|---|
| | lb. | lbs. | lbs. | lbs. | Grammes. | |
| Italian Rye Grass (23) | 15·0 | 4·65 | ·68 | 12·9 | 22·50 | 8·85 |
| Turnips | 30·0 | 1·20 | ·12 | 2·7 | 6·81 | 15·43 |
| Oats | 4·0 | 2·48 | ·30 | 3·5 | 1·92 | 0·16 |
| Dec. Grd. Nut Cake | ·5 | ·35 | ·21 | ·45 | ·32 | 1·56 |
| Pea Meal | 3·0 | 2·16 | ·54 | 2·60 | 1·09 | 5·85 |
| Linseed Cake | 2·5 | 1·80 | ·61 | 2·20 | 3·97 | 8·73 |
| Palm Kernel Cake | 2·0 | 1·50 | ·31 | 1·78 | 2·36 | 4·26 |
| Total in rations | .. | 14·14 | 2·77 | 26·13 | 38·97 | 44·84 |
| "Standard" requirements | .. | 14·20 | 2·76 | 25—30 | 67·30 | 38·00 |
| Difference— | | | | | —28·33 | +6·84 |

Ca/P ratio:—·87.

*The Calcium and Phosphorus Content of Hay.*

| No. | Description | Total Ash | Silica-free Ash | 100% Dry matter basis | | Uniform 10% moisture | | Ratio. |
|---|---|---|---|---|---|---|---|---|
| | | | | CaO | $P_2O_5$ | Ca | P | Ca/P |
| | | % | % | % | % | % | % | |
| 57 | Timothy and Cocksfoot . | 6·25 | 3·78 | ·32 | ·49 | ·21 | ·19 | 1·1 |
| 58 | Meadow Hay . . . | 7·55 | 5·60 | ·84 | ·36 | ·54 | ·14 | 3·8 |
| 59 | Italian Rye . . . | 7·05 | 4·01 | ·49 | ·47 | ·32 | ·18 | 1·8 |
| 60 | Italian Rye and little Clover. | 5·16 | 4·36 | ·78 | ·38 | ·50 | ·15 | 3·3 |
| 61 | Timothy and Cocksfoot . | 7·01 | 4·73 | ·64 | ·54 | ·41 | ·21 | 1·9 |
| 63 | Meadow Hay . . . | 5·92 | 4·22 | ·59 | ·46 | ·38 | ·18 | 2·1 |
| 64 | Meadow Hay . . . | 5·38 | 4·57 | 1·26 | ·41 | ·81 | ·16 | 5·0 |
| 65 | Italian Rye and Clover . | 5·99 | 4·67 | 1·17 | ·39 | ·75 | ·16 | 4·7 |
| 66 | Cocksfoot, Timothy and Clover. | 5·54 | 4·31 | ·65 | ·53 | ·42 | ·31 | 2·0 |
| 67 | Italian Rye, Timothy, Cocksfoot. | 5·06 | 3·40 | ·60 | ·40 | ·39 | ·16 | 2·4 |
| 68 | Canadian Timothy . . | 6·41 | 3·09 | ·60 | ·46 | ·39 | ·18 | 2·2 |
| 69 | Italian Rye, little Clover . | 5·08 | 3·60 | ·86 | ·33 | ·55 | ·13 | 4·2 |
| 70 | Meadow Hay . . . | 10·10 | 7·17 | 1·91 | ·48 | 1·23 | ·19 | 6·5 |
| 71 | Clover and Italian Rye . | 6·75 | 5·75 | 1·48 | ·49 | ·95 | ·19 | 5·0 |
| 72 | Italian Rye . . . | 5·76 | 3·66 | ·62 | ·41 | ·40 | ·16 | 2·5 |
| 73 | Meadow Hay . . . | 6·92 | 4·63 | 1·04 | ·44 | ·67 | ·18 | 3·7 |
| 74 | Clover and Italian Rye . | 7·47 | 6·23 | 1·25 | ·40 | ·81 | ·16 | 5·0 |
| 75 | Clover and Italian Rye . | 7·44 | 6·67 | 2·21 | ·58 | 1·42 | ·23 | 6·2 |
| 76 | Meadow Hay . . . | 5·52 | 4·49 | ·86 | ·62 | ·55 | ·25 | 2·2 |
| 77 | Meadow Hay . . . | 6·19 | 4·26 | ·55 | ·55 | ·36 | ·22 | 1·6 |
| 78 | Meadow Hay . . . | 7·82 | 4·89 | 1·13 | ·51 | ·72 | ·20 | 3·6 |
| 10 | Meadow Hay . . . | 6·18 | 4·00 | 1·18 | ·44 | ·76 | ·18 | 4·2 |
| 16 | Meadow Hay . . . | 7·32 | 4·99 | ·91 | ·55 | ·58 | ·22 | 2·6 |
| 17 | Clover Hay . . . | 6·78 | 5·28 | 2·04 | ·48 | 1·34 | ·19 | 7·0 |

*The Calcium and Phosphorus Content of Hay*—contd.

| No. | Description | Total Ash | Silica-free Ash | 100% Dry matter basis | | Uniform 10% moisture | | Ratio |
|---|---|---|---|---|---|---|---|---|
| | | | | CaO | $P_2O_5$ | Ca | P | Ca/P |
| 18 | Clover Hay . . . | 7·14 | 6·35 | 1·57 | ·46 | 1·00 | ·18 | 5·5 |
| 19 | Clover Hay . . . | 6·47 | 5·74 | 2·30 | ·29 | 1·48 | ·11 | 13·4 |
| 31 | Meadow Hay . . . | 4·71 | 3·47 | ·51 | ·63 | ·33 | ·25 | 1·3 |
| 40 | Meadow Hay . . . | 6·99 | 5·60 | ·76 | ·75 | ·49 | ·29 | 1·7 |
| 41 | Italian Rye, Timothy Clover. | 7·70 | 5·61 | 1·08 | ·67 | ·70 | ·27 | 2·6 |
| 21 | Italian Rye . . . | 4·80 | 3·09 | ·68 | ·36 | ·44 | ·14 | 3·1 |
| 22 | Italian Rye and Clover . | 4·45 | 3·14 | 1·00 | ·34 | ·64 | ·14 | 4·6 |
| 23 | Italian Rye . . . | 3·73 | 2·67 | ·51 | ·32 | ·33 | ·13 | 2·5 |
| 45 | Italian Rye and Clover . | 5·79 | 3·41 | 1·14 | ·36 | ·73 | ·14 | 5·2 |
| 45*a* | Italian Rye, less Clover . | 4·61 | 2·43 | ·51 | ·33 | ·33 | ·13 | 2·5 |
| 46 | Italian Rye and Clover . | 4·72 | 3·45 | ·72 | ·33 | ·46 | ·13 | 3·5 |
| 47 | Meadow Hay . . . | 5·53 | 4·49 | ·66 | ·57 | ·43 | ·22 | 2·0 |
| 80 | Clover Hay . . . | 8·89 | 7·33 | 1·78 | ·69 | 1·13 | ·27 | 4·2 |
| 81 | Italian Rye and Clover . | 6·10 | 5·24 | 1·34 | ·38 | ·86 | ·15 | 5·7 |
| 82 | Cocksfoot and Italian Rye | 6·73 | 4·72 | ·60 | ·47 | ·39 | ·18 | 2·2 |
| 83 | Italian Rye . . . | 4·97 | 3·78 | ·69 | ·38 | ·44 | ·15 | 2·9 |
| 85 | Italian Rye . . . | 5·81 | 4·86 | ·62 | ·50 | ·40 | ·20 | 2·0 |
| | Mean values . | .. | .. | 0·99 | 0·46 | 0·63 | 0·20 | .. |

supply the tissues with that which is lacking in the food. This, in its turn, leads to a breakdown and discharge of associated osseous mineral constituents; thus a shortage of one mineral in the food may have far-reaching effects. The importance of avoiding a marked calcium-phosphate imbalance, with a preponderance of phosphate coupled with vitamin A deficiency, in connection with the formation of stone in Indian cattle has been clearly demonstrated by McCarrison.[13] McCarrison's

investigations will surely do much to convince the surgeon and the pathologist of the important part that correct feeding may play in preventing disease.

A factor which surely must be of significance in mineral assimilation is the water-supply and its method of intake. Experiments have been conducted to assess the value of a constant supply of water to cows in regard to increasing the milk yield, but the extraction of the ultimate half-gallon of milk from a cow is not the be-all and end-all of dairy husbandry. While the introduction of water-bowls may not, in certain instances, have caused an increase in the milk yield, clinicians and farmers know that this rational method of watering has undoubtedly improved the health of stock and reduced, on many farms to a considerable extent, the incidence of gastro-intestinal disturbances and, therefore, one may assume that it has a beneficial effect on mineral metabolism.

The value of good hay to cows, and to horses, is not restricted to its energy and mineral content As is now well-known, the importance of good haymaking lies not only in securing a crop with a plentiful supply of digestible nutriment but also with its vitamin content as little impaired as possible. And one must keep in mind that because a high percentage-assimilation of calcium and phosphorus may be obtained in the West, with timothy hay or alfalfa grown and harvested under good climatic conditions, it is not necessarily the case that similar results would be obtained with much of the hay harvested in Britain. We do not know what the vitamin content of British hays is; in certain seasons one could scarcely expect it to be high. G. V. Hart[14] discussed the importance of vitamin conservation in hay at the recent International Veterinary Congress and showed that excessive weathering materially reduces the anti-rachitic D factor. In this connection the experimental work on the Nutritive Value of Pastures by Woodman, Blunt and Stewart[15] and other workers at Cambridge and the investigations of the Imperial Chemical Industries, Ltd., into the methods of drying young grass are of moment and promise to be of great benefit to stock in the near future.

It is significant that many horse-owners in this country show a general preference for Canadian timothy hay and Western grown oats in place of British hay and grain, which horses seem to find less palatable. It is also known that dairymen prefer hay grown in certain districts to that obtained from others. The preference for Western hay and grain cannot be attributed to any differences in the mineral content, except in the case of alfalfa, but the British dairymen's preference for certain regional fodders is probably due to differences in total nutriment including minerals rather than to a higher vitamin value. As an instance of this, reference may be made to three lots of Italian rye grass hay, Nos. 21, 22 and 23. These were the first three prize crops grown in a certain area in Scotland and surprise having

been expressed regarding their general poverty in protein, soluble carbohydrates and silica-free ash, the information was given that the dairymen in Edinburgh recognise that this type of hay gives poor results when fed to their cows. This opinion was supported by a well-known pedigree stock-breeder who stated in reply to an inquiry that these hays "were no use at all." It is to be noted that all three samples are deficient in silica-free ash as well as being deficient in total nutriment.

The fact that Theiler, Green and du Toit[16] have stated that the requirements of cattle in South Africa for vitamins, A, B and C are slight and readily supplied by roughage does not necessarily mean that this applies to cows in Britain, and in regard to D it is more than probable that, lacking sunlight, an additional supply throughout the winter months would be helpful. Investigators are in agreement that the addition of green and other succulent foods is an aid to calcium assimilation and, long before scientific experimentation as we now know it was undertaken, the beneficial effects of grass, roots and carrots were well known to stockowners, in particular to town horse owners and clinicians. The addition of vitamin D to the diet of cows is becoming more general and because of this the work of Harris and Innes[17] should be carefully considered.

Harris and Innes (1931) working with rats and rabbits have produced evidence supporting the theory that vitamin D exerts its action by raising the blood Ca and/or P, so giving rise to increased calcification. The addition of vitamin D causes an increased net-absorption of Ca and P from the gut with consequent hypercalcæmia and/or hyperphosphatæmia and resultant calcareous deposition in the soft tissues. While at first this excess of vitamin serves to promote osteogenesis in the later stages the shaft of the bone acts as a further reservoir of these minerals. In the case of the low calcium diets the bones are the main source of the calcium and phosphate; generalised osteoporosis resulting from excess D feeding. Two methods of mobilisation are therefore involved, depending on the Ca and P content of the diet and the degree of excess of the vitamin D.

One can but state here briefly that the results of this work indicate that the provision of an adequacy of calcium and phosphorus in the diet is of equal importance as a sufficiency of vitamin D. Also that it leaves one with the impression that the administration of vitamin D to cows must only be undertaken when the calcium and phosporus content of the whole diet has been duly considered. The necessity for taking care in the administration of vitamin D has also been emphasised by Steenbock and Wirick[18] who state that excessive quantities in the diet may cause harmful results by the deposition of calcium in the soft tissues.

The use of cod-liver-oil as an anti-rachitic agent and also for its anti-infective powers is becoming general. Professor Wm. Mitchell found cod-liver-oil to have a

marked beneficial effect on box-fed sheep, preventing and curing rickets, and also that it removed the "stiffness" of cattle associated with winter feeding in courts. Some investigators have found it to have a depressing effect on milk yield. Woodman and Evans found that it impaired the appetites of experimental sheep[10] and that it did not cause an increase in calcium assimilation, notwithstanding the fact that the animals must have been, as they say, in need of skeletal calcium. On the other hand, veterinarians and farmers do not appear to have experienced any difficulty in getting stock to consume a reasonable amount. Cod-liver-oil would appear, then, to be a useful supplement to the winter diets of cattle, but at the same time care should be taken to see that the ration is liberally supplied with calcium and phosphorus. What constitutes a "sufficiency" of either calcium or phosphorus for dairy cows does not seem to be known. Indeed, the factors making for a good assimilation are of such a nature, and so little understood, that no rigid standard can be laid down.

To the veterinarian the real matters at issue are the extent to which dairy cows are subjected to calcium and phosphorus deficiency and if the health of the cows and their capacity for breeding healthy calves are being impaired. Estimations have been made of the assumed loss of calcium from the body during a lactation period, this has been put as high as 25 per cent. of the total bone reserves, which may or may not be made good during the dry period and when the animals are at grass. It seems almost incredible that a cow could lose one-quarter of the calcium from her bones without exhibiting some clinical evidence of the fact; yet we do know that great changes can take place in osseous tissue and remain unsuspected.

Calcium deficiency has been held responsible for many bovine ills, including retention of the placenta, an increased susceptibility to tuberculosis, abortion and sterility. What evidence is there in support of these contentions?

This Conference offers an opportunity for discussing these matters and bringing to the front the much-needed clinical evidence of true calcium deficiency in British cattle, if such exists. In writing this paper the intention has not been to produce either new facts or new theories, but rather to invoke discussion among practitioners of a subject that hitherto has been somewhat obscure.

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# UNDULANT FEVER IN MAN AND ABORTION DISEASE IN CATTLE.

## Some Facts that the Consumer and Producer of Milk and the Breeder of Cattle Should Know.

BY

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During the past few months, much publicity has been given to the problem of undulant fever in man. Some of this publicity has left the lay reader with the impression that the disease in man comes *wholly* from the consumption of raw milk from abortion-diseased cows. The available knowledge at this time indicates that this is not true. Just how much undulant fever there is in this country at this time no one can say. (In 1928 and the first five months of 1929, there was a total of 1,034 cases reported from 42 states.) Also, it is impossible, with the available knowledge, to point to the most common source of infection.

### PROBABLE ANIMAL CARRIERS.

In order to get a broader perspective of the problem, it is necessary to know that there are now recognized three types of the germ that may cause undulant fever in man: 1st, the goat type; 2nd, the cow type; and 3rd, the pig type. In those countries where goats are extensively used for milk production, undulant (or Malta) fever has been recognized for many years. No one at this time is in a position to state definitely which type of the germ is the most frequent cause of the disease in man in the United States. Hardy, of the Hygienic Laboratories and Department of Preventive Medicine, College of Medicine, State University of Iowa, isolated 28 strains from humans, 21 of which he considered to be of the pig strain. However, of 22 strains isolated by Huddleson from cases in Michigan only one was considered by him to be of the pig strain. Because of the apparent wider distribution of the cow type in America, it has been the opinion of most investigators that this type is the most frequent cause of the disease in man. As indicated above, no one at this time can difinitely point to all possible sources of infection nor point out the most important one. The available information, though limited

in amount, indicates that the consumption of raw milk is not as important a source of infection as others. In abortion-diseased cows, the organisms are present in the udder in only about 50 per cent. of the cases, and in these as a rule only in relatively small numbers. With the exception of Texas, Arizona, and New Mexico, the goat type is probably not important as a cause in the United States. The general opinion is that man is most susceptible to the goat type. However, it has been found that the guinea pig and monkey are more susceptible to the pig type, and there is an increasing opinion that man may also be more susceptible to the pig type than to either of the other two types.

### Apparent Low Susceptibility of Man to infection from Milk.

The limited data at hand seem to present further evidence of the relatively low susceptibility of humans to the infection in milk. Huddleson and Orr made a study of 500 inmates of a state institution. This particular institution was selected because raw milk was made a part of the daily diet of the inmates. The milk and cream supply was produced entirely by the dairy herd belonging to the institution During the past few years, practically all the herd had been infected with contagious abortion, and the abortus bacilli could be readily isolated from the milk. Most of the inmates who were studied had been in the institution for several years and therefore had been exposed to infection during their entire stay. Two hundred and fifty men and 250 women were included in the study. Only three inmates gave a suspicious reaction to the test and four gave positive reactions. Of the four, three were women and one was a man. Only one of these had a clinical case of the disease. The abortion organism was isolated from this case.

### Evidence Indicates disease an occupational one.

There is no evidence that human males are more susceptible to the infection than females, yet Hardy states that among the farm residents there were nine times as many cases among men as among women. There is no reason to assume that women consume less milk than men. The evidence seems to indicate that contact with infected animals is a greater source of infection than the consumption of milk. Hardy reports on a study of 222 cases in Iowa with reference to occupation. He found the incidence of undulant fever in towns of less than 5,000 population to be 8·3 persons per 1,00,000 population. Among the rural population, it was 11·4 persons per 1,00.000 population. Among packing house employees it was 287·5 persons per 1,00,000 population. However, the milk consumed by rural population and by the population of towns of 5,000 and less is as a rule raw. The fact that the prevalence of undulant fever among packing house employees is 25 to 30 times as great as that among raw milk consumers leads to the belief that this

is an occupational disease coming from direct contact with infected animals rather than through milk consumption. Even in the rural population, largely consumers of raw milk, it appears to be an occupational disease, since nine times as many men as women in rural sections have contracted the disease.

It is our hope that the above discussion will not be interpreted as an attempt to belittle the importance of a milk supply free from the abortion disease organisms. No raw milk should be consumed if there is a probability that it contains germs pathogenic for man. However, we believe that recent propaganda has overestimated the dangers of acquiring the infection through the use of milk and has unduly excited the uninformed consumer of milk.

In this connection we wish again to quote Dr. Hardy who has given this problem as much study as any one in America: "A conservative attitude is justified since it appears obvious that the disease is not a new one but one newly recognized. In many respects the knowledge of undulant fever is very inadequate and one cannot wisely at this time make hasty conclusions or incriminating statements. Much economic waste and even impairment of human health (through a decreased consumption of milk) may be avoided if we are content to study carefully and quietly and then act wisely."

THE ECONOMIC IMPORTANCE OF THE DISEASE IN DAIRY HERDS.

There is an economic phase of this problem which the producer of milk and breeder of cattle should consider very seriously, aside from its possible relation to human health.

Graham, of the Illinois Station, studied the milk records of an infected herd over a period of four years. He estimates that the lowered milk production of the aborting cow amounts to a loss of $54 annually. Davis, of the Nebraska Station, is quoted as estimating the annual loss per aborting cow in the Station herd at $107. White and other investigators of the Storrs, Connecticut, Station have reported on a study of this problem extending over a period of eleven years. They estimate the annual loss per reacting cow at $44·01 ; $28·41 of this amount was the estimate due to loss in milk production. It should be noted that this estimate is made on the reacting cow and is not limited to the aborting cow. Not all reacting cows abort. If the lowest estimated economic loss is applied to the situation in Michigan at this time, with a conservative estimate of 15 per cent. infection in herds, it is estimated that infectious abortion is causing an annual loss to Michigan dairymen of no less than $5,644,000.

It is the opinion of the Dairy Department, Michigan State College, that the future prosperity of Michigan dairymen will depend as much upon the steady sale of surplus cattle as upon the sale of milk products.

Restrictions are now being placed on the intra-state movement of cows reacting to the abortion test. Within the State, they can be sold only for immediate slaughter or to go into infected herds under certain conditions. Furthermore, at this time 15 states have laws or regulations prohibiting the shipment into the state, except for immediate slaughter, of cattle which react to the abortion tests. It is predicted that within two to five years every state in the Union will have such laws or regulations. It is obvious that if Michigan breeders are to have a favourable market, either within the state or in other states, for their surplus cattle their herds must be free of abortion disease.

## WHAT MICHIGAN DAIRYMEN SHOULD DO.

The Michigan cattle breeder can no longer ignore the abortion problem. Economic pressure is forcing him to face it. What should be done? After many years of study of this problem we are convinced that the solution is the same one that has been used against several other plagues that threatened the prosperity of the cattle industry in this country. In the '80's of the last century contagious pleuro-pneumonia of cattle was stamped out of this country because it menaced the cattle industry. Foot and mouth disease has been stamped out on several occasions. Only a few counties in the southern states remain quarantined because of southern cattle fever, and tuberculosis will soon be eliminated from our herds. Michigan is almost "over the top" at this time with its state-wide tuberculosis eradication campaign.

We are confident that abortion disease will be disposed of in the same way as the other serious cattle plagues which have confronted us in the past. We believe there is no ground for excitement over the problem. It should be faced with conservatism, and no drastic and hasty procedure should be undertaken at this time. It is none too soon, however, for the dairyman and especially the cattle breeder to study his herd carefully and to know thoroughly his true situation and to lay plans for the building up of an abortion-free herd.

The breeder who already has a clean herd is indeed fortunate and should be more than careful, through the utilization of all present information, to keep his herd clean. To this man will come the ever-increasing demand for disease-free milk and replacement cattle.

The desire to produce a healthful food product, the economy of its production, and the future prosperity of the dairy cattle industry in Michigan makes a careful, sane, and conscientious study of the abortion problem by the dairymen of the state of prime importance at this time. A prompt utilization of the means that have been demonstrated to be effective in economically and successfully dealing with it is equally important.

# ABSTRACTS

**[We are indebted to the Imperial Bureau of Plant Genetics, Herbage Plants, Aberystwyth (Wales), for the following six abstracts of current publications.]**

**Sunflowers, variety and strain tests for yield.** (*Report of the Superintendent of the Cap Rouge Experimental Station*, pp. 22-23, Ottawa, 1930.)

After it has been decided to grow some crop for ensilage, the next thing to find out is what will give the best results. The following figures show that, under conditions similar to those at Cap Rouge, a suitable variety of sunflowers will yield more dry matter per acre than corn :—

| Crop. | Raw matter per acre. | Per cent. dry matter. | Dry matter per acre. |
|---|---|---|---|
| | Lb. | | Lb. |
| Sunflowers . . . . . . . | 29,735 | 21·03 | 6,353 |
| Corn . . . . . . . . | 26,098 | 18·14 | 4,734 |

The percentage of dry matter looks abnormally high for sunflowers and low for corn, but samples were carefully taken and analysed at the Division of Chemistry, Ottawa. Henry gives 12·6 for the total digestible nutrients in 100 pounds of dry matter of sunflower silage, and 13·3 for immature corn silage, so that the difference is negligible from this standpoint. It can thus be said that sunflowers may advantageously replace corn for silage purposes in Central Quebec, although peas and oats or green clover may still be more profitable on account of the high proportion of protein.

The table which follows gives details about varieties of sunflowers tested at Cap Rouge :—

| Variety or strain. | Source. | Green matter per acre. | Per cent. dry matter. | Dry matter per acre. |
|---|---|---|---|---|
| | | Lb. | | Lb. |
| Giant Russian . . . . | Disco . . | 37,177 | 18·09 | 6,725 |
| Mammoth Russian . . . | McDonald . | 36,480 | 15·99 | 5,833 |
| Ottawa 76 . . . . . | C. E. F. . . | 25,550 | 13·75 | 3,513 |
| Mixed Mennonite . . . | Rosthern. . | 21,446 | 12·40 | 2,659 |

The years during which the varieties and strains of sunflowers were compared are not the same as the ones when sunflowers and corn were compared, which explains the difference in per cent. of dry matter in sunflowers for the two projects.

Russian is the best variety to use, and the main point is to get the best possible strain of it. [Quotation in full.]

**Studies on the improvement of national veld pastures.** A. D. HUSBAND AND A. P. TAYLOR. (*Rhodesia Agricultural Journal*, Vol. 28, No. 2, pp. 154-169, Salisbury, 1931.)

1. The bulk of hay obtained over a period of two years from a plot which received one normal dressing of complete fertiliser was 132 per cent. higher per acre than from a corresponding adjoining plot which received no fertiliser. In the latter plot the yield was just over 11/4 tons per acre; in the former it was just over 3 tons.

2. The crude protein content of the normal veld grass was found to be much below the standard of a natural average European grass. It was highest in January, with a total of 7·40 per cent., after which it rapidly declined to the miserable figure of 1·73 per cent.

3. Monthly clipped grass intended to simulate close grazing, have much higher figures, rising to 10·79 per cent. crude protein at the beginning of March, and only falling to 9·09 per cent. in April, when the rains had virtually ceased.

4. The phosphatic content of the young grass, grazed monthly, was strikingly higher than that of the mature herbage. The former reached its summit in March with ·841 per cent. phosphoric oxide, which is more than 2½ times the amount contained in the mature grass on the same date.

The phosphoric oxide in the mature grass was low throughout, decreasing rapidly after the dry season commenced.

5. The remaining mineral analyses indicate that our natural grasses suffer from a decided deficiency, but that this deficiency, though not so pronounced in the early part of the season, becomes extremely so in most instances from the month of March onwards.

Further, by a system of close grazing, the total mineral content steadily increases up to at least the month of April.

6. Ether extract is consistently low and crude fibre very high, but the latter lowers steadily under a close-grazing practice.

7. The nutritive ratio of the mature herbage widens from 1 : 11·4 at the height of the growing season in January to the appalling ratio of 1 : 53·4 in October, the average from May to November being 1 : 48·8.

On the other hand, the close-grazed quadrats show an average of 1 : 10, the ratio narrowing to the useful one of 1 : 7·3 in March.

**The importance of the shape of plots in field experiments.** BASIL G. CHRISTIDIS. (*Journal of Agricultural Science*, Vol. 21, Part 1, pp. 14-37. Cambridge, 1931.)

1. In agricultural experiments it seems that significant results can not be secured by only using appropriate statistical methods; uniformity amongst the individual plots is more essential than anything else.

2. Some theoretical considerations suggest that the shape of the plots constitutes an important means of controlling soil heterogeneity. In accordance with these: (*a*) in no case can square plots be more uniform than long and narrow ones; (*b*) the smaller the value w/l the more uniform the experimental plots, and (*c*) since uniformity depends (apart from w/l) on the value of the angle "a" in some exceptional cases (soil fertility varying gradually and evenly, and angle "a" approaching 90°) the advantage of the long plots may be less than would be anticipated. This, however, is most unlikely on account of the complexity of the variation in soil conditions and the possibility of easily avoiding such a critical value of the angle "a".

3. In order to test the validity of the assumptions made regarding the effect of the shape of the plots, the numerical data of several uniformity trials have been considered. A close agreement was found between expectation and actual results in the great majority of cases the evidence being remarkably significant in favour of the long plots. In only three cases were the results inconclusive, this apparently being accounted for by the way in which the original plots were formed, causing an inequality in area amongst them.

4. In the light of these investigations, in order to reduce the effect of soil heterogeneity, the plots used should be as long and narrow as possible. This, of course, within the limits set by different practical considerations, amongst which convenience, competition (when acting), and the accurate measurement of the width appear to be the most important.

**Ueber das Erreichte und noch Erreichbare der Futterplansenzuchtung in osthreussen. (Forage plant breeding in East Prussia, what has been attained and what remains to be done.)** FELDT. (*Mitt. d. Ver. z. Ford. d. Moorkultur i. Deut. Reiche*, Vol. 49, No. 1, pp. 7-14, Berlin, 1931.)

The author draws attention to a Law of Nature, which runs: "Every bred strain gives its maximum yield only on that climate from which it emanates," and points out the futility of breeding on one type of soil forage plants destined for use in a province consisting of at least fifty different soil types, each of which requires a special form of plant. If for the present it remains impossible to establish breeding centres upon the fifty different soil types, at all events the six principal types should be worked upon, namely, sand, middling soil, clay soil, normal low-lying moorland, low-lying alluvial moorland, and high moorland. (The present East Prussian breeding station is situated on slightly loamey sand.) In recognition of this principle breeding was started some years ago on marshland subject to periodical flooding with valuable results. It should be possible to produce forms suited not only to the different soil types, but to different purposes. The forms desirable for East Prussian conditions are enumerated and the work being carried out at the East Prussian Breeding Station at Konigsberg is described.

**The Illini soybean, a superior new variety. Effects of inoculation and liming on soybeans,** pp. 12 and 14. (*Iowa Agricultural Experiment Station*, Annual Report, 1930, Ame, Iowa, 1930.)

*The Illini soybean, a superior new variety.*

The Illini, a new variety of soybean developed at the Illinois Experiment Station, has been tested at the Iowa Station during the past two years and is apparently superior to any of the

varieties grown in Iowa at present. The results indicate that the Illini may be expected to yield at least 10 per cent. more than the varieties now grown. It is believed to be well suited for general planting throughout the state. (Quotation in full.)

*Effects of inoculation and liming on soybeans.*

The effects of inoculation and liming have been studied on soybeans grown on Grundy silt loam, an acid soil extensively developed in southern Iowa. The inoculated plots yield twice as much hay and about three times as much seed as the uninoculated plots. The protein content of the hay was doubled and that of the seed was increased one-third by the inoculation. The increases in yield and in protein content of soybeans with inoculation were greater when the soils had received sufficient lime to neutralize the acidity. (Quotation in full.)

**Lucerne breeding.** R. E. DWYER. (*Agricultural Gazette of New South Wales*, Vol. 42, Part 1, pp. 49-52, Sydney, 1931.)

The culture of lucerne has extended rapidly during recent years on upland soils in drier and colder districts on the Western Slopes and Tablelands of New South Wales. It is now largely grown as a grazing crop on typical wheat soils, where the rainfall is over 20 inches. With this rapid extension of lucerne growing into different climatic and soil conditions there has arisen a definite need for the development of breeding of types and strains which are adapted to these conditions.

The close inspection of lucerne fields readily reveals marked variations between the individual plants in habit, leafiness, type, and vigour of growth, etc., and the aim of the breeder is to secure a strain which will uniformly reproduce the type and vigour of the best plants in such a field. This cannot be done simply. Lucerne is to some extent cross-fertilised, and the selection of seed from the best individual plants in a field will only reproduce the heterogeneous types of which the original field is composed.

Continued selection in self-fertilised lines is regarded as the best basis of improvement, and the experience with this method at Bathurst Experiment Farm during the past three or four years is given. (*Author's summary.*)

**Effect of season of Calving on Milk Yield and Calving period of Montgomery cows.** L. S. JOSEPH AND C. N. DAVE. (*Ind. J. Vet. Science and Anim. Husb.* 1, 212.)

With the object of studying the relationship between yields per lactation and intervals between successive calvings, and the effect of the season of calving on milk yield, 11 years' records of the Pusa Pedigree Sahiwal herd were gone through. They lead to the following inferences:

1. The month of calving and the milk yield indicate no co-relation although the autumn or rain calvers show a decrease in the average lactation yield, which may probably be attributed to change in climatic conditions which prevent the animals from taking regular exercise in the open air.

2. The average calving period along with the wet and the dry periods remain unaffected irrespective of the season of calving. [L. S. J. and C. N. D.]

**The Diagnosis of Johne's Disease—Some Experimental Results using a "Bowel-washing" method.** HUGH COOPER AND M. K. SRINIVASAN. (*Ind. J. Vet. Sci. and Anim. Husbandry*, 1, 215.)

Johne's disease is a chronic affection of the intestine of cattle due to a specific organism. Spread of the disease is very slow and diagnosis of it becomes one of the most important considerations in attempting its control. It is believed that the disease is much more prevalent among cattle in India than is at present realised. Animals in good condition and apparently quite healthy may be infected and capable of spreading the disease in a herd at least several months before clinical symptoms of the disease attract the attention of the owners. The technique of methods used in the diagnosis of the disease with some experimental results concerning a useful new method are included in the article. [H. C. and M. K. S.]

**Studies on Platyedra gossypiella, Saunders, in the Punjab, Part II.—The sources of Platyedra gossypiella infestation.** M. AFZAL HUSAIN, S. S. BINDRA, LADHA RAM, GANDA RAM AND DEV RAJ. (*I. J. Agri. Sc.* 1, 204.)

In the Punjab *Platyedra gossypiella* infestation is carried from one year's cotton crop to that of the next by the long-cycle worms. The survival of the long-cyclers, therefore, is of importance in the incidence of attack. The hibernating caterpillars may be found in :—

1. bolls present on plants left standing after harvest ;
2. fallen bolls lying on the soil ;
3. bolls or cotton-seeds buried under-ground ;
4. cotton and cotton-seeds taken by rats and mice into their burrows ;
5. bolls on cotton-sticks stored for fuel ;
6. ginning trash ;
7. stored *kapas* ;
8. stored cotton-seeds ;
9. seeds sown ;
10. alternative food-plants.

In 1 and 2 all the caterpillars die on account of sun-heat before May ; in 3 only an occasional moth emerges ; in 4 all the caterpillars are eaten up ; in 7 very little *Kapas* is left unginned after June ; 9 and 10 are not important sources of re-infestation. It has been found that 5 and 6 are subsidiary sources of infestation, while 8—stored cotton-seeds—in which a very high percentage of long cyclers survives, is the main source of infestation.

Sun heating of the cotton-seed is an effective method of killing hibernating caterpillars in seed and can be widely applied in the Punjab. In the ginning factories the treatment of seed by heat or vacume fumigation should be made compulsory.

**The inheritance of characters in Setaria italica (Beauv.), the Italian millet, Part I.—Grain colours.** G. N. RANGASWAMI AYYANGAR and T. R. NARAYANAN. (*I. J. Agri. Sci.* 1, 587.)

Six grain colours have been noted in *Setaria italica*. These fall into two groups (*a*) Black, Tawny Buff, and Korra Buff, and (*b*) Sepia, Red and Tawny Red. A factor K (after Korra,

the Telugu name for this millet) is present in group (*a*) and absent in group (*b*). In each of these groups the basic colours Tawny Red and Korra Buff, with the addition of a factor I, turn into Red and Tawny Buff. This Red and Tawny Buff with the addition of another factor B turn into Sepia and Black respectively. Factor B has an individuality, but its presence is not visible except in association with I.

The behaviours of over five hundred families are presented in support of the above hypothesis. Three sets of artificial crosses furnish confirmatory evidence. [G. N. R. and T. R. N.]

**Inheritance of Red Corolla Colour in some Indian Cottons.** G. L. KOTTUR, B. B. MUNDKUR AND S. S. MARALIHALLI. (*Ind. J. Agri. Sci.* **1**, 578.)

This article reports on the inheritance of red anthocyanin pigment present in the petals of some Indian cottons. One cross was made with a yellow-flowered type as the female parent. In the $F_1$ generation, red colour of the corolla was found to be dominant, though some dilution of the parental colour was apparent. In the $F_2$ generation the segregation was on the basis of a simple Mendelian ratio. In the other crosses where a white-flowered type was used, and of which there were two crosses under study, $F_1$ generation reaction of petal colour was as in the previous case but in the $F_2$ progeny inheritance was on the basis of a 9 : 3 : 3 : 1 ratio, the segregates being red, pink, yellow, and white respectively. $F_3$ generation segregations were according to expectations. It is concluded that there are two factor pairs, one for pink and the other for yellow, the presence of both being necessary for the production of red colour. The white flowered varieties are double recessives, while the yellow-flowered one had the dominant yellow factor and also the other recessive factor. [G. L. K., B. B. M. and S. S. M.]

**A Bacterial White Soft Rot of Turnip.** HARIHAR PRASAD. (*Ind. J. Agri. Sci.* 1, 534.)

A white soft rot of turnip was noticed at Pusa in February, 1931, doing considerable damage. The disease appears in any part of the roots and may be caused by wound either during intercultivation or by insects. The symptoms of the disease and the descriptions of the causative organism differ in some respects from the published description of similar diseases of turnips. The causative organism is *Bacillus aroideæ* Townsend. Rotation with other crops, the fruits of which do not come in contact with soil, is suggested as a preventive measure. [H. P.]

**Effect of Mosaic Disease on the Yield and the Juice of Sugarcane in Pusa in 1931.** W. McRAE (*Ind. J. Agri. Sci.* **1**, 527.)

Though in tropical lands noble canes infected with mosaic disease show a great reduction in tonnage and considerable reduction in available sucrose, yet, with the exception of Hemja, the thin canes of northern India that are infected do not show striking reductions of this kind. Eye observation of the standing cane does not reveal any marked difference in tonnage though there is a belief in the mill that the available sucrose is reduced. In Pusa for the last year or two, the amount of spread in the growing crop has been small so conditions seemed to be favourable for a field-experiment consisting of a series of adjacent pairs of plots of mosaic-infected and mosaic-free cane. In 1930 accordingly plots of Coimbatore Seedling canes Co. 213 and Co. 215 were laid down so that differences could be more accurately determined. The former is the cane that has found favour in the white-sugar tract of north Bihar and Co. 205 was a good

cane for the poorer class of land though it has fallen now into disfavour because of its high fibre content.

The mosaic-infected cane was taken from plots wholly infected with the disease and setts were cut from canes whose leaves showed mosaic markings at the time of harvest. Thus there was no doubt about the cane being infected. The mosaic-free cane was taken from plots that were frequently observed during the growing season and were found to be entirely free from the disease and setts were cut from canes that at the time of harvest had no mosaic markings on their leaves. Thus the cane was definitely known to be mosaic-free when planted.

The area in which Co. 213 was planted was good, even, heavy land suitable for growing cane while that in which Co. 205 was grown was light high land, rather lighter than is considered good for cane but it was the only site available seeing the main cane area had to be protected from the disease. There was extremely little damage done by other diseases or by insects and animals so in these respects the experiments were wonderfully fortunate.

During the season a small amount of infection spread to the mosaic-free plots. In the case of Co. 213 it amounted to 0·1 per cent. and of Co. 205 to 0·7 per cent. These amounts are far too small to have any appreciable effect on the yield. It is indeed this low rate of spread that has rendered the experiment practicable in its present form.

After leaving out sufficient cane round each plot to eliminate edge effect, the 10 pairs of plots were each 150 by 21 feet in the case of Co. 213 and the eight pairs of plots were 120 by 12 feet in the case of Co. 205.

The mean average weights of stripped cane in maunds were—

| | Mosaic-free. | Mosaic-infected. | Deficient. |
|---|---|---|---|
| In Co. 213 . . . . | 48·80 | 46·55 | 2·2 or 4·6 per cent. |
| In Co. 205 . . . . | 8·53 | 7·79 | ·74 or 8·6 per cent. |

Thus the reduction in tonnage is comparatively small. With regard to the juice it became evident that equal weights of mosaic-infected or mosaic-free cane produced equal quantities of juice, and that in Co. 213 the sucrose and purity were slightly reduced while the glucose was higher but in Co. 205 the differences were too small to be significant.

These results may be taken as applicable to Coimbatore seedling canes in north Bihar and the adjacent tracts of the United Provinces but they may or may not be applicable to the rest of Northern India. Experiment alone in several places can settle this point. The conditions in South and Western India are so different that these results can hardly have any value there and it is possible and perhaps likely that greater losses may occur both in tonnage and quality of juice. [W. M.]

**Calf Rearing.** E. J. SHEEHY. (Paper read before the Congress of the Irish Dairy Shorthorn Breeders' Association, January 1931, at Limerick.) *The Farmers' Gazette.* January 17, 1931.

### I.—CAUSE, PREVENTION AND TREATMENT OF NUTRITIONAL SCOUR.

For the purpose of some feeding experiments on calves conducted during the past three years it was necessary to purchase a considerable number of "dropped," *i.e.*, newly-born,

calves from calf dealers. The intention was to rear all the animals on whole milk, followed by some separated milk, up to the age of six weeks, at which age the experiments proper were planned to begin. Very great difficulty was met with in the rearing; a considerable number of deaths took place in the first year, and some occurred in the second. The problems of rearing were, therefore, taken in hands experimentally, and a solution of the principal difficulty, namely, the occurrence of nutritional white scour, *i.e.*, diarrhœa, due to incorrect feeding, was sought. A fairly large proportion of the calves born throughout the country each year die in the baby stage, and it is common knowledge that deaths among bought-in dealers' calves are, in proportion to their numbers, very much greater than in the case of those born on the farm and fed on their mothers' milk. In certain parts and on certain farms the losses are colossal, in some cases the casualties amounting to 100 per cent. It would be very interesting to have an estimate of the number of deaths among young calves annually, but, in the absence of any definite information on the subject, I venture to think that the amount of money lost to the farming community as a whole through deaths in calves would amount to a very high figure. The question will be immediately asked: Are such losses preventible, or, at least, can their number be reduced to a much lower figure?

Before replying directly to that question, it is necessary to investigate the cause or causes of death and the circumstances under which on certain farms casualties are greater than on others. The experimental evidence from the University Farm at Glasnevin throws much light on the subject in so far as one cause of death which is responsible for a high proportion of the casualties is concerned. In December, 1928, twenty-three freshly-dropped calves were purchased and housed in comfortable and clean pens. They were fed twice daily, each calf receiving 4 pints of milk for the first few days, 6 pints—3 pints each feed—per day for the remainder of the first week, 7 to 8 pints thereafter until the end of the second week, increasing up to 10 pints daily subsequently. It should be mentioned that more than 50 per cent. of the calves had not received colostrum or biestings before arriving at the farm, and that the milk they received during rearing was from a group of cows which were nearly half-way through their lactation period. Though carefully managed, quite a number of calves, soon after arrival, developed colds, which, however, could not be accounted for by a possible chill during transit, because in many cases a week or more elapsed before the symptoms of the cold developed. One individual died of pneumonia as a result, and another got such a severe set-back that he remained under-developed for a very considerable time. Though the feeding pails were scrupulously clean and the milk fed was freshly drawn, several of the calves at various stages of growth up to three weeks went off their appetite, became lethargic, and developed scour. Notwithstanding the application of all kinds of suggested treatment, out of 23 calves only 17 survived at the end of the third week, and some of these were much the worse from protracted attacks of diarrhœa or scour and accompanying disorders. The foregoing, it is submitted, is not an unusual history for a batch of "bought-in" calves receiving ordinary food treatment.

### Experiments in 1929.

In December 1929, a lot of twenty-nine calves was procured under similar circumstances. Of these some had biestings to drink, but the majority received no food whatsoever before arrival at the farm. They were fed in a similar fashion to the 1928 calves with mixed milk from a group of cows. On arrival, however, each calf received an ounce of castor oil, so as to dislodge any fæces lying in the lower intestine, and possibly to prevent subsequent diarrhœa,

Colds appeared, as in the previous year, and the lack of appetite and disordered conditions accompanied by scour, which proved so troublesome in 1928, again developed, spasmodically at first, and more generally later on.

### Alteration in the Feeding.

With the theory that the disorders above described were due in all cases to stomach irritation, experimental alterations were made in the feeding. Prior to this quite a number of suggested remedies, such as the boiling of the milk, the giving of boiled starch, laudanum and brandy (2) the internal administration of a small quantity of formalin, and so on, has been tried, but without definite effect. Two calves, about 12 days old, which were seriously ill and scouring badly, had their food altered from milk to a mixture of 50 per cent milk and 50 per cent. water, which was fed four times daily, one pint being given at each feed. In a short time the calves showed signs of relief ; twenty-four hours later they were much more vivacious, and showed more interest in life and in the feeding pail. The ration was increased to 8 pints daily, *i.e.*, 2 pints at each feed, and the improvement gradually proceeded till at the end of about a week the calves had recovered and the scouring had ceased.

The same experiment was repeated with like success on two other sick calves, and again on still two others. In this last case treatment started with the entire replacement of the milk by water, 2 pints of which were fed three times daily for one day, after which the same quantity of equal parts of water and milk were fed three times daily. The improvement in the calves which received only water for a day was more rapid than in the others and this was particularly noticeable in the vivacity of the animals. One other ill calf was similarly treated, with the same result. From this time onwards the food of all the calves in the group, with the exception of two, consisted of diluted, rather than undiluted, milk, and very little trouble appeared among them thereafter. The two excluded animals, which were then 18 days old, were in the early stages of the disease condition, which had hitherto given so much trouble, and for which a definite cure had been found.

In order to confirm the conclusion arrived at regarding the cause of death in earlier cases these two calves received all the unadulterated milk they would consume twice daily, so as to aggravate the disorder of the stomach. One animal consumed more milk than the other, though the appetite of both was irregular. On occasion the one would consume its full ration greedily, and on a particular morning after having partaken freely the previous evening he was found dead in the pen. Post-mortem examination revealed a very badly congested stomach wall, blood mixed with the stomach contents, and a hard mass of curd so large that it completely filled the stomach cavity. Obviously the animal had died from the experimental diet provided, and death was hastened by thirst, which induced him to drink more milk than his stomach was capable of dealing with. The second calf drank less freely, and he lingered on, the scouring still continuing, for about a fortnight, when death occurred. Post-mortem examination again revealed a congested stomach wall, but only small portions of curd in the stomach cavity. The difference in the prolongation of life in the two cases was obviously connected with the amount of curd accumulated in the already overtaxed and disordered stomach.

### Experiments in 1930.

In December, 1930, twenty-nine calves were brought in, as in previous years. They were fed, as before, on the mixed milk of five cows, which were about three months calved. The

first lot of six to arrive were fed 2 pints of unadulterated milk three times per day, and this was to be increased to 2½ pints each feed after the first week. Notwithstanding the reduced quantity of milk at each feed, five of the six calves developed scour before the end of the week, and thereby got a very severe set-back. The treatment found so successful in the previous year, namely, a dose of castor oil after at least three hours fast, followed by a diet of water only, fed three times per day (2 pints each feed) for one day, and a like quantity of milk and water in equal proportions for the next couple of days, was immediately adopted with success. A suitable dose of castor oil is 1 ounce for an animal a week old, 1½ ounces at the age of two weeks, and 2 ounces by the end of the third week. The next lot of twelve calves to arrive were given milk and water mixed in the proportions of 5 to 1, and fed three times daily. Much less trouble was experienced with this lot, but, nevertheless, some cases of scouring did develop. These were successfully treated by a dose of castor oil and water, followed by the 50-50 milk and water. Occasional cases of off appetite and scouring continued to appear, and it was decided to dilute the milk much more.

NEW SYSTEM OF FEEDING.

Thenceforward all the calves on hand, as well as other eleven which arrived, were given at each feed—three times daily—from ¾ to 1 pint of boiled water mixed with its quota of milk, the exact quantities of fluid given three times daily being :—

| | | Milk. | | Water. |
|---|---|---|---|---|
| 1st week of | calf's life | 1¾ | pints and | ¾ pint. |
| 2nd ,, | ,, | 2 | ,, | 1 ,, |
| 3rd ,, | ,, | 2½ | ,, | 1 ,, |
| 4th ,, | ,, | 3 | ,, | 1 ,, |

With the introduction of this system the worry of rearing the calves ceased. Occasionally a calf did go off appetite, and scouring developed, but a dose of castor oil, followed by a day's rations on water alone, succeeded by a few days on 50-50 milk and water, completely removed the trouble. Previous years' experience taught that when a calf refused its feed, partly or entirely, the refusal was to be taken as a warning of impending trouble. Accordingly, instead of endeavouring to make the calf drink more than it wished, a dose of castor oil was immediately administered, and the 50-50 milk and water or water alone given for a few days, when appetite and normal conditions of health were restored. As a matter of fact, it was almost invariably found that the warning mentioned was followed by scouring, and by providing the dose of laxative, and the subsequent treatment before the scour actually appeared, the disturbance, which otherwise might have continued over a week, was curtailed to a period of a few days. Apart from the appearance of an occasional disturbance, such as that mentioned, and which, when it did occur, was quite easily corrected, the new system of feeding was remarkably successful. The dull and listless eye so familiar when milk alone was fed was replaced by an alert and lustrous one, and the improved appetite was indicated by the congregation of the calves round the doorway on the approach of meal time. Hitherto numbers of them had to be roused from a lying posture for their feed. The animals now showed all the symptoms of good health as contrasted with the evidence of internal trouble and pain previously so familiar. It should be mentioned that occasionally an affected calf got so weak

as to entirely lose its appetite, in which case the prescribed treatment was carried to its logical conclusion by dosing with water till the appetite returned.

### Irritation caused by unadulterated milk.

The evidence clearly shows that scouring in calves is caused, not necessarily, however, in all cases, by irritation of the stomach, due to the consumption of unadulterated milk. The condition described in this paper must not however, be confused with the contagious white scour, which is due to a specific organism, which enters the body through the navel shortly after birth, or to scour due to other causes, and possibly arising from the activity of organisms in the intestinal tube. Possibly the milk of the freshly-calved cow is more easily digested by the stomach of the calf than is that of animals more advanced in the lactation period. The stomach irritation which is liable to be caused by unadulterated milk so accelerates the rate of movement of the intestine (peristaltic action) as to drive on the fluid content thereof before it is absorbed. Animals which are scouring are, therefore, very poorly nourished ; hence the characteristic emaciated appearance. Severe irritation of the stomach, such as follows when indigestible collections of curd appear there, results in pain, which becomes acute unless the cause is removed. Removal of the cause consists in the giving of relief to the stomach, which is effected by feeding the calf on either water or very watery milk. The gastric juice is thus given an opportunity to act on the curd, and the stomach wall is given a very necessary rest for recuperation.

### Summary.

Disorders of the food tube, which culminate in scouring or diarrhœa and their accompanying ill effects, are, during the early weeks of the calf's life, frequently due to the feeding in large quantities, at long intervals, of unadulterated whole milk, which taxes the stomach so heavily that the organ becomes disorganised and ceases to function normally. The conclusion of previous observers that calves which do not receive biestings at the start of life are much more susceptible to this disorder of the food tube, as well as other diseases, than are biestings fed animals, is confirmed. The severe irritation of the stomach wall caused by injudicious feeding produces, by reflex action, such a rapid increase in the muscular movements (peristalsis) of the intestines as to cause diarrhœa. Prevention lies in the dilution of the milk with water as described (two or three parts of milk to one of water) the mixture being fed in the quantities prescribed. The distribution of the daily in-take of fluid into three feeds also helps. The cure of the disorder consists in dosing the calf with castor oil, limiting the food to boiled water only, for one day, and to 50-50 milk and water for some days thereafter till recovery is complete.

### References.

(1) "On Raising Suckling Pigs by Hands." By Golding. "Pig Breeders' Annual, 1928-29."

(2) Leaflet No. 54. "The Breeding and Rearing of Calves." Ministry of Agriculture, Northern Ireland.

(3) "Fundamentals of Dairy Science." By Associates of L. A. Rogers. Pages 416 to 422.

(4) "Colostrum : Immunization of New-born Calves." By Smith and Little. *Science* 71. No. 1850 X (June 13th, 1930).

**The Influence of Frequency and Cutting on the Productivity, Botanical and Chemical composition and the Nutritive Value of 'Natural' Pastures in Southern Australia.** J. G. DAVIES and A. H. SIM. (*Pamphlet No. 18 of the Council for Scientific and Industrial Research, Commonwealth of Australia, 1931*).

(1) The highest yield of dry matter is obtained from a natural pasture by allowing the herbage to reach maturity. More frequent cutting tends to reduce the yield, fortnightly cuts seriously depressing the dry matter produced per acre. Pasture cut three times during the season yielded approximately 94 per cent. of the yield obtained from one cut, and produces herbage of higher nutritive value and lower fibre content than mature herbage.

(2) During the greater part of the season, rainfall is the most important factor governing the yield from fortnightly cuts. There is a lag in the effect of rainfall on yield. The yield of a given fortnight being greatly influenced by the rainfall during the preceding fortnight.

(3) Throughout the season, temperature exerts a profound modifying influence, and during July seriously limits the growth of the pasture. Towards the end of the season both temperature and rainfall become limiting factors to growth.

(4) Severe defoliation is demonstrated to reduce the yield of the erect species, whilst certain rosette species, *e.g.*, *Erodium botrys*, give a higher yield per acre when the pasture is cut at fortnightly intervals.

(5) The calcium content of the herbage is high. This is attributed to the high proportion of species rich in lime that constituted the herbage from all series.

(6) The different frequencies of cutting do not appreciably influence the lime content of the herbage.

(7) The highest production of lime per acre is obtained when the pasture is cut at intervals of 6-8 weeks.

(8) The percentage of $P_2O_5$ in the herbage is low compared with the percentages obtained from Continental pastures. It is, however, very similar to the results obtained from certain South African pastures. The highest production of $P_2O_5$ is obtained from Series 3 in 1927 and Series 2 in 1928.

(9) The $P_2O_5$ content of fortnightly and monthly cuts is almost identical. With less severe cutting, however, the $P_2O_5$ content drops markedly to a minimum in the herbage at maturity.

(10) The $P_2O_5$ content is maintained throughout the season when the pasture is cut at fortnightly intervals.

(11) The calcium-phosphorus ratio is very high in all cases, but is reduced when the pasture is cut at fortnightly intervals.

(12) The herbage from fortnightly and monthly cuts is more than twice as rich in crude protein as the mature herbage from a single cut.

(13) The highest production of crude protein is obtained from pasture cut at 2-4 weekly intervals, the higher protein content of the young herbage more than counterbalancing the depressed yield.

(14) Pasture cut at fortnightly intervals is lowest in percentage crude fibre. With decreased frequency of cutting, the crude fibre content steadily rises.

**Results of a three years' study of certain Poultry Rations as they effect the Hatching Power of Hen Eggs as well as the Number of Eggs Laid.** W. R. GRAHAM, J. B. SMITH and W. D. McFARLANE. (*Ontario Department of Agriculture Bulletin 362, March 1931.*)

| Ration. | Summary of three years' results per cent, hatchability. | | | | | | Egg production 11 months. | Lbs. feed to produce one dozen eggs. | Average feed consumed per Bird. | Total eggs set for three years. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Feb. | March. | April. | May. | June. | July. | | | | |
| Milk, beef, C. L. O. | 76·9 | 75·2 | 60 | 59·6 | 66·5 | 74·5 | 165·6 | 5·87 | 81 | 5,851 |
| Milk, fish, C. L. O. | 79·2 | 74 | 58·8 | 63·3 | 67·9 | 67·4 | 166·6 | 5·91 | 82 | 5,730 |
| Milk, irradiation . | 74·1 | 77·2 | 71·7 | 74 | 79·5 | 77·1 | 139·8 | 7·01 | 81·7 | 4,782 |
| 10 per cent. milk, C. L. O. | 73·4 | 69·9 | 60·6 | 54·8 | 64·1 | 65·4 | 153·5 | 6·48 | 82·8 | 5,430 |
| *37 per cent. milk, C. L. O. | 75·8 | 75·7 | 65·8 | 74·1 | 80 | 73·3 | 153·7 | 6·07 | 77·8 | 3,682 |
| Milk, tank., C. L. O. | 72 | 58·6 | 58·7 | 42·7 | 55·6 | 60·4 | 151 | 6·41 | 80·7 | 5,256 |
| Beef, C. L. O. . | 69·2 | 67·4 | 59·9 | 71·9 | 70·6 | 72 | 164·2 | 5·95 | 81·3 | 6,103 |
| Fish, C. L. O. . | 64·3 | 60·2 | 50·3 | 63·6 | 66·4 | 67·5 | 177·8 | 5·64 | 83·6 | 6,575 |
| Fish . . . | 57·4 | 59·3 | 53 | 56·6 | 69·4 | 71·8 | 165·4 | 6·18 | 85·1 | 5,958 |
| Milk . . . | 56·3 | 56·1 | 59 | 71·7 | 72·8 | 74·8 | 143·6 | 7·05 | 84·4 | 4,985 |
| Beef scrap . . | 51·2 | 47·4 | 44·6 | 55 | 68·6 | 63·6 | 138·4 | 7·01 | 80·9 | 4,683 |
| Milk, Fish Scrap . | 58·2 | 49·1 | 30·9 | 42·6 | 64·5 | 68·1 | 141·4 | 6·78 | 79·9 | 4,630 |
| Tankage, C. L. O. | 27·9 | 41·2 | 28·7 | 39·4 | 57·8 | 57·6 | 157·2 | 6·05 | 79·3 | 5,890 |
| Tankage . . | 10·2 | 21·7 | 29 | 34·9 | 48·4 | 55 | 126·6 | 7·44 | 78·5 | 4,523 |

* Two years.

# NOTES

## NOTE ON THE PRODUCTION OF SUGAR DIRECT FROM CANE DURING THE SEASON 1930-31.

Twenty-nine factories making sugar direct from cane worked in India during the season 1930-31 as against twenty-seven in the previous season. Eleven of these are situated in the Province of Bihar and Orissa, thirteen in the United Provinces, one in Bombay, two in Madras, one in Punjab and one in Burma. A new factory in the Punjab started working during the season under report.

The production of sugar direct from cane by factories in India totalled 32,62,574 mds. or 119,859 tons during the season 1930-31 as against 24,43,486 mds. or 89,768 tons during the previous season. There was thus an increase of 819.088 mds. or 30,091 tons in the output of sugar during the campaign of 1930-31 as against 1929-30. The table below shows the quantity of cane crushed and sugar made by the factories in (1) Bihar and Orissa, (2) United Provinces, and (3) Bombay, Madras, Punjab and Burma.

*Total for Bihar and Orissa.*

| | 1929-30 mds. | 1930-31 mds. |
|---|---|---|
| Cane crushed | 1,12,94,684 | 1,43,36,013 |
| Sugar made | 10,05,797 | 13,14,412 |
| Molasses obtained | 3,94,730 | 5,42,225 |
| Recovery per cent. | 8·90 | 9·17 |

*Total for the United Provinces.*

| | 1929-30 mds. | 1930-31 mds. |
|---|---|---|
| Cane crushed | 1,29,82,302 | 1,76,05,483 |
| Sugar made | 11,67,992 | 15,63,095 |
| Molasses obtained | 4,66,508 | 6,17,933 |
| Recovery per cent. | 9·00 | 8·88 |

**Total for Bombay, Madras, Punjab and Burma.*

| | 1929-30 mds. | 1930-31 mds. |
|---|---|---|
| Cane crushed | 26,64,723 | 39,14,006 |
| Sugar made | 2,69,697 | 3,85,067 |
| Molasses obtained | 1,02,149 | 1,51,494 |
| Recovery per cent. | 10·12 | 9·84 |

* Figures for 1929-30 exclude Punjab.

*Grand Total.*

| | 1929-30 mds. | 1930-31 mds. |
|---|---|---|
| Cane crushed | 2,69,41,709 | 3,58,55,502 |
| Sugar made | 24,43,486 | 32,62,574 |
| Molasses obtained | 9,63,387 | 13,11,652 |
| Recovery per cent. | 9·07 | 9·09 |

It will be noticed from the above table that in the year 1930-31, the supplies of cane available for crushing were considerably larger in all the Provinces than in 1929-30.

The average percentage recovery of sugar in India also shows an improvement, having risen from 9·07 to 9·09 in 1930-31. It is gratifying to note that the general efficiency of the factories making sugar direct from cane is steadily increasing. Out of the 29 factories that worked in India during the season 1930-31 the percentage recovery of two factories is above 10, of twelve factories above 9, of eleven factories above 8 and of only four below 8.

During the season 1930-31, India's production of molasses by modern factories making sugar direct from cane totalled 13,11,652 mds. as against 9,63,387 mds. in 1929-30, or an increase of 3,48,265 mds. over the previous season.

A review of the last five seasons' average percentage recovery of sugar from cane is given in the table below. It will be seen that the factories in Bihar and Orissa continue to maintain satisfactory improvement, whereas the factory side of the industry in the United Provinces, Bombay, Madras, Punjab and Burma taken together shows a drop in recovery during 1930-31 in comparison with the last year.

| Name of the Province | 1926-27 recovery per cent. | 1927-28 recovery per cent | 1928-29 recovery per cent. | 1929-30 recovery per cent. | 1930-31 recovery per cent. |
|---|---|---|---|---|---|
| Bihar and Orissa | 8·67 | 8·80 | 8·61 | 8·90 | 9·16 |
| United Provinces | 7·93 | 8·07 | 8·37 | 9·00 | 8·88 |
| Bombay, Madras, Punjab and Burma | 10·26 | 10·09 | 9·93 | 10·12 | 9·83 |
| Total for India | 8·49 | 8·62 | 8·59 | 9·07 | 9·09 |

Statistics regarding the production of refined sugar by refineries in India will be collected, collated and published in due course.

I take this opportunity of expressing my thanks to the Proprietors and the Managing Agents for supplying the statistics worked up in this note. [R. C. SRIVASTAVA.]

## THE IMPERIAL AGRICULTURAL BUREAUX.

The Imperial Agricultural Bureaux have, during the last few months, undertaken the periodical issue of abstracts (or extended titles) of current literature in the branches of science in which they are interested. Brief particulars are as follows :—

| Title. | Issued by the Imperial Bureau of. | How issued. | Price | |
|---|---|---|---|---|
| | | | Annual subscription. | Single copies. |
| | | | s. | s. d. |
| Plant Breeding Abstracts. | Plant Genetics, Cambridge, England. | Printed (quarterly). | 5 | 1 6 |
| Herbage Abstracts . | Plant Genetics, (Herbage Plants) Aberystwyth, Wales. | Printed (quarterly). | 5 | 1 6 |
| Technical Communications. | Soil Science, Rothamsted, Harpenden, Herts, England. | Duplicated . | Various. | .. |
| Horticultural Abstracts. | Fruit Production, East Malling, Kent, England. | Printed (quarterly). | 5 | 1 6 |
| Veterinary Bulletin . | Animal Health, Weybridge, England. | Printed (quarterly at present). | 20 | 7 6 |
| Animal Nutrition Abstracts and Reviews. | Animal Nutrition Rowett Research Institute, Bucksburn, Aberdeen, Scotland. | Printed (quarterly). | 21 | 6 0 |
| (a) Quarterly Bulletin | Animal Genetics, Edinburgh. | Printed (quarterly). | Free at present s. 5 p. a. next year. | 1 6 |
| (b) Monthly List of References. | Animal Genetics, Edinburgh. | Duplicated (monthly). | Free at present. | |

The Rothamsted list of extended titles will include the titles of all articles which the Bureau have indexed on their cards so that any research worker who takes in this journal will have at hand a complete index of the current literature available at Rothamsted. The same is true of the Imperial Bureau of Animal Genetics except that certain references collected for visiting research workers to the Department of Animal Genetics and not of interest to the general worker in this field are omitted. Thus the list of titles is to some extent selected, but the widest possible range is covered with regard to the needs of the correspondent of the Bureau.

It will be noted that all the publications have been priced. This is necessary as there is clearly a limit to which the Bureaux can undertake the free distribution

of their literature. On the other hand arrangements have been made to supply a considerable number of copies free varying with the different publications.

The number of free copies of Animal Nutrition abstracts and reviews is strictly limited. This journal is a joint effort on the part of the Executive Council of the Imperial Agricultural Bureaux, the General Medical Research Council and the Reid Library at the Rowett Institute, Aberdeen. The scientific reason for this joint effort is apparent. On questions of nutrition it is impossible to draw a strict line between the research undertaken primarily for human benefit and that undertaken primarily for the benefit of stock. Both those who are working on human problems and on stock problems are interested in each others' progress in research. As three different bodies are financing this venture it was found necessary to limit the number of free copies issued.

Concurrently with the issue of these abstracting journals, papers will be issued by all the Bureaux on particular technical problems or containing bibliographies on special research questions as hitherto.

### PLANT BREEDING ABSTRACTS.

The Imperial Bureau of Plant Genetics has begun to issue a publication entitled " Plant Breeding Abstracts " in which all the more important current publications dealing with plant breeding and the genetics of crop plants are listed. The references are classified according to subject and each reference is followed by an abstract indicating the subject matter of the paper and the results obtained. The papers are divided into two halves, those published in the British Empire and those published in foreign countries. Papers written in foreign languages are usually abstracted somewhat more fully than papers in English.

" Plant Breeding Abstracts " is issued quarterly and Vol. I, No. 3 which was published on April 1st, 1931, contains 197 references covering 52 pages.

The annual subscription for the publication is at present 5*s*. post free, single copies being obtainable at price of 1/6. Subscriptions should be sent to the Deputy Director, Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England.

## THE BOARD OF ECONOMIC ENQUIRY, PUNJAB.

A meeting of the Board of Economic Enquiry, Punjab, was held by Mr. Calvert, Financial Commissioner (Development), Chairman of the Board, in Lahore on Wednesday the 22nd April 1931.

The meeting was informed that reports of the village surveys of Jullundur, Rohtak and Lyallpur districts are now in the press; and then proceeded to consider

those of Rawalpindi, Gujranwala, Multan, Sialkot and Hissar which are in preparation for the press; also those of Gurdaspur, Kangra, Attock, Lahore, Gurgaon, Jhelum, Montgomery which are with the members in charge of the sub-committees. Village surveys for the districts of Muzaffargarh and Ferozepore are in progress.

Among the miscellaneous enquiries, it was stated that the reports of the Farm Accounts in the Punjab for the year 1928-29 had been printed and that copies had been sent to members, while a large portion of the same report for the year 1929-30 had been sent to the press and the remainder of it had been received from Professor Kartar Singh, the author.

Those under preparation are the reports of Enquiries into the Milk Supply of Lyallpur and Lahore; Marketing conditions and Practices in the Punjab; Weights and Measures; the Economic Conditions of Gur-makers in the Punjab; the Economic Aspects of Cultivation of Lac in the Punjab; a Cattle Survey of the Rohtak District and a Note on Food Prices, 1921-30, etc.

# Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

With reference to the Government of India, Department of Education, Health and Lands, Notification No. 1605-Agri., dated the 17th September 1929, Diwan Bahadur Sir T. Vijayaraghavacharya, K.B.E., on his retirement from the Madras Civil Service has been re-employed as Vice-Chairman of the Imperial Council of Agricultural Research with effect from the forenoon of the 27th August 1930.

His Excellency the Governor-General in Council is pleased, under the provisions contained in Rules 1 and 43 of the Rules and Regulations of the Imperial Council of Agricultural Research, to appoint the following as members of the Imperial Council of Agricultural Research and also as members of its Advisory Board :—

1. Director of Agriculture, Mysore.
2. Superintendent, Civil Veterinary Department, Mysore.

His Excellency the Governor-General in Council has been pleased, under the provisions contained in Rules 1 and 22 of the Rules and Regulations of the Imperial Council of Agricultural Research, to appoint the member in charge of Agriculture, Mysore Executive Council, as a member of the Imperial Council of Agricultural Research and also as a member of its Governing Body.

In pursuance of clause (XI) of section 4 of the Indian Cotton Cess Act, 1923 (XIV of 1923), the Governor-General in Council has been pleased to appoint Mr. Girdharlal Kotak to be a member of the Indian Central Cotton Committee, Bombay, for a period of 3 years from the 1st April 1931.

### *Madras.*

MR. G. R. HILSON, B.Sc. (EDIN.), I.A.S., Officiating Director of Agriculture, Madras, has been granted leave on average pay for two months and thirteen days and leave on half average pay for one year, two months and ten days in continuation thereof, with effect from 14th May 1931.

MR. R. C. BROADFOOT, Officiating Principal, Agricultural College, Coimbatore, on relief by Mr. C. Tadulinga Mudaliyar, has been appointed to officiate as Cotton Specialist, Coimbatore, until further orders.

The following probationers have been appointed to be members of the Madras Agricultural Service in Class I with effect from the dates noted against them :—

1. Mr. M. U. Vellodi, L.Ag.,— 7th October 1929.
2. ,, R. Swami Rao, L.Ag.,—10th October 1929.
3. ,, G. Jogi Raju, Dip. Agri.,—14th October 1929.
4. ,, M. Viraraghava Rao, L. Ag.,—15th October 1929.

MR. D. BALAKRISHNAMURTI, DIP. AGRI., Deputy Director of Agriculture, II Circle, Madras, has been granted leave on average salary for one month and twenty-eight days preparatory to retirement with effect from 17th August 1931. Mr. C. RAMASWAMI NAYUDU, B.A. (Cantab.), District Agricultural Officer, Guntur, has been appointed to be in charge of the current duties of the post in addition to his own until further orders.

MR. K. S. VISWANATHA AYYAR, B.A., Assistant Agricultural Chemist, Coimbatore, has been granted leave on half average salary for four months from date of relief.

MR. P. A. RAGHUNATHASWAMI AYYANGAR, Upper Subordinate, I grade, Assistant in Chemistry, has been appointed to be Officiating Assistant Agricultural Chemist, Research Institute, Coimbatore, *vice* Mr. K. S. Viswanatha Ayyar granted leave.

### *Bombay.*

MR. J. P. DAMRI has been appointed to be Assistant Professor at the Bombay Veterinary College, *vice* Mr. P. F. Miranda, G.B.V.C., retired.

MR. M. N. GOKHALE, has been allowed to continue to act as Assistant Professor of Chemistry, Agricultural College, Poona, *vice* Mr. V. G. Patwardhan on leave.

## *Bengal.*

MR. G. S. DUTT, I.C.S., Collector of Birbhum, has been appointed to be an official member of the Board of the Agricultural Department in Bengal, reconstituted in Resolution No. 43-T. A. I., dated the 23rd April 1930.

MR. G. S. Dutt, I.C.S., Collector of Birbhum, has been appointed to be an official member of the Bengal Silk Committee, reconstituted under the Bengal Agricultural Department Resolution No. 3508-Agri., dated the 19th July 1930.

## *United Provinces.*

MR. G. CLARKE, C.I.E., I.A.S., Director of Agriculture, United Provinces, has been granted leave out of India on average pay for eight months, with effect from July 2, 1931, followed by leave on half average pay up to and including October 22, 1933, preparatory to retirement.

MR. N. C. MEHTA, I.C.S., Director of Land Records, United Provinces, has been appointed to hold charge of the duties of the Director of Agriculture, United Provinces, in addition to his own duties, with effect from July 2, 1931.

MR. N. C. MEHTA, I.C.S., Director of Agriculture, United Provinces, has been appointed to be Vice-Chairman of the United Provinces Agricultural Research Committee *vice* Mr. George Clarke, C.I.E., proceeded on leave preparatory to retirement.

Rai Bahadur S. C. BANERJI, Assistant Agricultural Chemist to Government, United Provinces, has been granted leave on average pay for four months with effect from July 1, 1931, or subsequent date of relief.

## *Punjab.*

MR. J. S. GAREWAL, M. R. C. V. S., I. V. S., has been confirmed in his appointment as Livestock Officer and Assistant to the Director, Veterinary Services (for breeding), with effect from the 13th March 1931.

MR. J. F. SHIRLAW, M. R. C. V. S., Professor of Pathology and Bacteriology, Punjab Veterinary College, Lahore, has been transferred to Muktesar, United Provinces, with effect from 13th June 1931. (Services placed at the disposal of the Government of India as Temporary First Veterinary Research Officer at the Imperial Institute of Veterinary Research).

The appointment of SETH MAHAMMAD SARWAR, M. R. C. V. S., to a special temporary post in the Civil Veterinary Department, Punjab, for a period of two years with effect from the 13th July 1929, has been extended for a further period of one year with effect from the 13th July 1931.

MR. W. S. READ, P. V. S., Assistant Superintendent (Fodder), Government Cattle Farm, Hissar, has been appointed as Officiating Superintendent, Government Cattle Farm, Hissar, with effect from the 29th June 1931.

S. SANTOKH SINGH, B.A. (Oxon.), B.Sc., (Agric.), Officer under training at the Government Cattle Farm, Hissar. is appointed as Officiating Assistant Superintendent (Fodder), Government Cattle Farm, Hissar, with effect from the 29th June 1931.

CH. JAINTI RAM, Officiating Deputy Superintendent, Civil Veterinary Department, Gurgaon, has been appointed as a Deputy Superintendent, Civil Veterinary Department, Rohtak, on two years' probation with effect from the 4th February 1931.

CH. JALAL MUHAMMAD KHAN, P.V.S., Deputy Superintendent, Civil Veterinary Department, Dera Ghazi Khan, has been confirmed in his appointment with effect from the 20th April 1931.

S. ASA SINGH, P. V. S., Deputy Superintendent, Civil Veterinary Department, has been confirmed in his appointment with effect from the 20th April 1931.

The Punjab Government (Ministry of Agriculture) has been pleased to order that the post of "Personal Assistant to the Director of Agriculture, Punjab" shall be designated "Assistant Director of Agriculture (Administrative), Punjab," with effect from the 16th June 1931.

DR. R. L. CHOPRA, M A., Ph.D., Assistant to the Entomologist to Government, Punjab, Lyallpur, and in additional charge of the duties of Entomologist to Government, Punjab, Lyallpur, has been appointed as Officiating Entomologist to Government, Punjab, Lyallpur, in addition to his duties as Assistant to the Entomologist to Government, Punjab, Lyallpur, with effect from the 21st July 1931.

S. LABH SINGH, L.AG., B.Sc., P. A. S., in charge of the duties of Associate Professor of Agriculture Punjab Agricultural College, Lyallpur, has been appointed as Officiating Professor of Agriculture Punjab Agricultural College, Lyallpur, *vice* Mr. D. P. Johnston, granted leave, with effect from the 21st February 1931.

S. KARTAR SINGH, L.Ag., B.Sc., N. D. D., P. A. S., Assistant Professor of Agriculture Punjab Agricultural College, Lyallpur, has been appointed to be in-charge of the duties of Associate Professor of Agriculture, Punjab Agricultural College, Lyallpur, with effect from the 21st February 1931, *vice* S. Labh Singh.

*Burma.*

On completion of his training, MR. J. SMIT , M. R. C. V. S., Veterinary Research Officer, is re-posted as Veterinary Research Officer, Burma, with head-quarters at Rangoon.

# REVIEWS

**The Agricultural Situation in 1929-30.**—(International Institute of Agriculture, Rome).

This very interesting publication is the first of its kind, published by the International Institute of Agriculture, the intention being that it should form the starting point of a series of Economic Commentaries on the agricultural situation of the world in general and of individual countries in particular. The agricultural industry in all countries is now passing through a grave crisis, and the causes that have led to it are of complex origin of a more or less general kind affecting the economic life of the whole world. Though monetary conditions and commercial policy are given as two powerful factors that have contributed to the present distress, the fundamental causes are traced to agriculture itself, to the changes that have taken place since the war in the different phases of the agricultural industry, and to the modifications that have arisen of the relations between supply and demand of agricultural produce in the world markets. The book under review analyses the general causes of world depression and examines the various influences to which each country is subject, also the methods, governmental or voluntary, adopted by it to alleviate the distress of the farmer.

The marketing of agricultural produce to meet the world requirements and the causes of the present low prices are examined. It is shown that cereals play a very important part in the present crisis and that they have influenced the position of other crops. The world production of wheat increased during the period 1909-13 to 1925-28 from an average of 823 million quintals to an average of 966 million quintals and allowing for an increased consumption owing to an increase of world population estimated at 10 to 11 per cent. during this interval, there was still a surplus of 5 to 6 million quintals. This fact is put forward to explain in part the congestion of the market and the accumulation of huge stocks. Besides, the authors state that the standard of world dietary seems to be changing and that the increase in consumption in urbanised areas of products containing concentrated nourishment such as dairy products and products of animal origin, has tended to diminish the use of starchy foods such as wheat. Amongst the other causes of decline in the aggregate demand for food grains, are mentioned the rapid development of mechanical transport replacing horse traffic whose rations consist mostly of oats, and the reduction in the world consumption of al-

cohol which needs cereals for its distillation and brewing. It is stated that as a consequence the prices of cereals have undergone considerable changes; the index numbers of the wheat prices given show that with 100 for the year 1926, the 1929 level stood at 79 and a similar story is told with regard to other agricultural products. The industrial crisis has influenced all branches of the farming industry, but its influence has been chiefly felt in the sphere of raw materials necessary for textiles. While there has been a continuous increase of world production in cotton, wool, flax, jute and hemp, the industry could not absorb all of them except at very low prices. The crisis rendered specially difficult by the fact that in face of a general collapse in prices, the costs of production refused to fall in the same proportion owing to heavy wages and social and fiscal changes. Thus countries have been forced to seek remedial measures to avoid the abrupt decline in prices. Canada with its Wheat Pool, U. S. A. with its Federal Farm Board, Australia and New Zealand with similar organisations are stabilising their home markets; while the importing countries threatened by foreign competition have raised tariff walls and have given subsidies to safeguard their own farmers.

Side by side with these measures, intended merely to give temporary relief to the farmer, most countries concerned are directing their energies towards effectively organising the distribution of products on the market and reducing the marketing costs. Attention is also drawn to the fact that a careful study is needed of the costs of production which should be kept as low as possible, the present agricultural crisis has acted as a stimulus for the development of farm accountancy and the scientific organisation of production. All this work of investigation in regard to agricultural economy and organisation is no less characteristic of the present agricultural situation than are the more practical measures taken by the Government or the parties concerned. It is pointed out that the cardinal problem of the present day is no longer that of ensuring production and of providing the needs of the world. but of securing an effective basis to avoid a crisis such as that with which the whole world is faced today. The various efforts and measures, taken by the Governments and voluntary organisations in individual countries to meet the situation are detailed in the book. The steps taken by the most organised and developed states in the world, such as U. S. A. and Canada, naturally differ from those in which agricultural methods are less advanced.

The International Institute of Agriculture has done good service in bringing out this publication, and it is hoped that the later volumes will extend the enquiry to other branches of the farming industry. [M. V.]

**Report of the Proceedings of the 4th World's Poultry Congress, at the Crystal Palace, London, England: July 22-30, 1930, pp. 1023.**—(His Majesty's Stationery Office, London: 1931.) Price 10*s*. 6*d*. net.

The official report of the 4th World's Poultry Congress recently published is a mine of authentic information on the latest advances in Poultry Husbandry and should be read by all who are interested in the scientific development of the industry.

The report of the proceedings is conveniently divided into six sections, including that devoted to rabbits, *viz* :

Section A.—Breeding and Incubation.
Section B.—Nutrition and Rearing.
Section C.—Diseases and their Control.
Section D.—Economics (including Marketing).
Section E.—Education and General.
Section F.—Rabbits.

In each section valuable papers, by experts of world-wide reputation, will be found which will well repay careful study by a wider public than those interested solely in poultry. For instance, the article by Dumon on the effects of in-breeding is a most valuable study of this much debated subject and the conclusions drawn therefrom might well be applied by breeders of live-stock of other sorts, in order to minimize the ill-effects of in-breeding, which in spite of its inherent dangers, has undoubtedly rendered great service in forming our modern breeds of live-stock.

The sections dealing with Nutrition, Diseases, and Economics in poultry husbandry are equally meritorious and should be of great practical value to all who are interested in any section of Animal Husbandry. [A. O.]

**Horticultural Abstracts, Vol. I, No. 1, March, 1931.**—Published by the Imperial Bureau of Fruit Production, East Malling, Kent, England. Price 5*s*. yearly.

A greater recognition of the value of research in food-production—a fundamental industry—has stimulated investigation in crop-production, as well as, in crop-utilisation. The problems involved are engaging the attention of a growing number of workers in different parts of the world. This necessitates a system of interchange of ideas and rapid dissemination of information obtained by different investigators, working in different countries and publishing the results of their researches in different languages. Therefore, to investigators and teachers, producers and consumers, nothing is more welcome than a publication which gives ready and up-to-date information regarding the investigations which are being carried out in different parts of the world, and the results obtained by different workers. The 'Horticultural Abstracts' satisfies this need in so far as the production, storage, transport

and utilisation of fruit are concerned. It also deals with crops like tea, cacao, coffee, etc., etc.

The first number covers the first quarter of the year 1931. The names of authors, the titles of papers and the names of periodicals appear in different types and in separate lines. Reference to the numbers of the Brussels International Decimal Classification is a useful feature of the Abstracts.

The classification of the abstracts under different heads necessitates cross-references. For instance, item 8. Gerhart—" Respiration in strawberry fruits ", should also be included under the head Physiology ; similarly, item 94. Auchinleck—" Storage of cacao in the tropics "should also be placed in the special division ' Storage and Transport '.

The paper and printing are excellent. We welcome this us eful publication. [M. A. H.]

# NEW BOOKS

## On Agriculture and Allied Subjects

Soil Management. By Norman E. Bear. Second Edition. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1931.) 17*s*. 6*d*. net.

Gardening Made Easy : the A. B. C. of the Garden. Edited by E. T. Cook. Ninth Edition, Revised and Enlarged. Pp. 222. (London : Country Life, Ltd., 1931.) 3*s*. 6*d*. net.

All about Gardening. By J. Coutts. New and Revised Edition. Pp. 384. (London : Ward Lock & Co., Ltd., 1931.) 5*s*. net.

Commercial Cucumber culture. By J. W. Craig. Second Edition, Revised and Enlarged. Pp. 47. (London : Ernest Benn, Ltd., 1931.) 2*s*. 6*d*. net.

The Profitable Small Farm. By E. Graham. Pp. 221. (London : Peter Davies, Ltd., 1931.) 7*s*. 6*d*. net.

The Principles of Potato Production. By E. L. Nixon. (New York : Orange Judd Publishing Co., Inc.; London : Kegan Paul and Co., 1931.) 7*s*. 6*d*. net.

Fruits and Fruit culture in the Dutch East Indies. By J. J. Ochse, in collaboration with Brink, R. C. Bakhulzen van den. English Edition of Vruchten en vruchtenteett in Nederlandsch- Oost-Indië (Batavia : G. Kolff and Co., 1931.) 17·50 guilders ; 7 dollars ; 30*s*.

Vegetables of the Dutch East Indies (Edible tubers, Bulbs, Rhizomes and Spices included.) : a Survey of the Indigenous and Foreign plants serving as Pot herbs and Side-dishes. By J. J. Ochse, in collaboration with Brink, R. C. Bakhuizen van den. English Edition of 'Indische Groenten' (Buitenzorg : Archipel Drukkerij, 1931.) 17·50 guilders ; 30*s*. ; 7 dollars.

The Making of New Grassland : Experiences of Practical Farmers, Being the Report of a conference held at Rothamsted on 11th February 1931, under the Chairmanship of Sir Daniel Hall. With Contributions by the Earl de la Warr, Sir John Russel, Sir Daniel Hall, J. Cruickshank, W. M. Findlay, A. MacArther, Major J. Keith, J. Alston, W. S. Mansfield, C. H. Gardner, Capt. A. R. McDougal, M. Jones and others. Pp. 61. (London : Ernest Benn, Ltd., 1931.) 2*s*. 6*d*. net.

Range Sheep and Wool in the Seventeen Western States. Part I : Range Sheep, by Fred S. Hultz ; Part II : Wool, by John A. Hill. Pp. XVII+374 (New

York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1931.) 15*s*. net.

Oil-cakes and Extracted Meals. By H. E. Woodman. Bulletin No. 11 of the Ministry of Agriculture and Fisheries. Pp. VIII+32. (London: H. M. Stationery Office, 1931.) 9*d* net.

The Scientific Aspects of Rabbit Breeding. By J. N. Pickard and F. A. E. Crew. Pp. IX+122+12 plates, (Watmonghs, Ltd., 1931.)

The Soil and the Microbe: An Introduction to the study of the Microscopic Population of the Soil and its Role in Soil Processes and Plant Growth. By S. A. Waksman and R. L. Starkey (The Wiley Agricultural Series.) Pp. XI+260. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1931.) 17*s*. 6*d*. net.

Researches on Fungi. Vol. 4: Further Observations on Coprini together with Some Investigations on Social Organization and sex in the Hymenomycetes. By A. H. R. Butler. Pp. XIII+329+4 plates. (London, New York and Toronto . Longmans, Green and Co., Ltd., 1931.) 21*s*. net.

Taxonomy of the Flowering Plants. By A. M. Johnston. (The Century Biological Series.) Pp. XXI+864. (New York: The Centry Co.; London: D. Appleton and Co., 1931.) 25*s*. net.

A History of Entomology. By E. O. Essig. (New York: Macmillan and Co., 1931.) 42*s*. net.

A Text-book of Experimental Cytology. By J. Gray. Pp. X+516. (Cambridge; At the University Press, 1931.) 25*s*. net.

Hand-book of Protozoology. By Richard Roksabro Kudo. Pp. VIII+451. (London: Baillière Tindal and Cox, 1931.) 25*s*. net.

The Regulation of Size as illustrated in Unicellular organisms. By E. F. Adolph. (General Biology Series, Vol. I) Pp. VIII+234. (London: Baillière Tindal and Cox, 1931.) 20*s*. net.

Plant Life through the Ages. A. Geological and Botanical Retrospect. By A. C. Seward. Pp. XXI+601. (Cambridge: At the University Press, 1931.) 30*s*. net.

Life: Outlines of General Biology. By Sir J. A. Thomson and Patrick Geddes. In two Volumes. Vol. I. Pp. XIX+714. Vol. 2. Pp. XI+715—1515. (London: Williams Norgate Ltd., 1931.) 63*s*. net.

Hand-book of Chemical Microscopy, Vol. 2. Chemical Methods and Inorganic qualitative Analysis. By E. M. Chamot and C. W. Mason. Pp. IX+411. (New

York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1931.) 22*s*. 6*d*. net.

Recent Advances in Microscopy: Biological Applications: Medicine. By A. Piney; The Living Eye. By Basil Graves; Zoology. By E. W. Macbride and H. R. Hewar; Botany. By E. C. Barton-Wright. Edited by A. Piney. Pp. VII+260. (London: J. and A. Churchill, 1931.) 12*s*. 6*d*.

The Chemical Activities of Micro-organisms. By A. J. Kluyver. Pp. 109. (London: University of London Press, Ltd., 1931) 4*s*. 6*d*. net.

Economic Biology: for Students of Social science. Part 2: Animal and Vegetable Products. By P. C. Esdaile. Pp. xv+231. (London: University of London Press, Ltd., 1931.) 10*s*. 6*d*. net.

# SUGARCANE SORGHUM HYBRIDS.

## (An Appeal for Seeds of Wild Sorghum.)

Having raised intergeneric hybrids between the sugarcane (P. O. J.-2725) and sorghum (Sorghum Durra, Stapf) for the last two seasons—over 75,000 in number —and having secured in the hybrids undoubted evidence of their hybrid nature, the time would appear to have arrived for fully developing this work.

The chief use for this hybridisation would appear to lie in the possibility of breeding short duration canes. Seven hundred hybrids planted out during the first season have yielded half a dozen types maturing in six months and with satisfactory juice. One direction, however, in which they could be improved with advantage is in the matter of tonnage. In future crossings it is proposed to use as parents on the sugarcane side not only canes more vigorous in growth than P. O. J.-2725 but also various forms of vigorous growing Saccharum spontaneum, of which a certain number are available at Coimbatore.

It is now desired to secure a collection of wild sorghums to try and introduce vigour—*i.e.*, tonnage—from the sorghum side also. The undersigned will feel highly indebted to persons or institutions that would kindly favour him with such seeds. Through the kindness of the authorities in the U. S. A. and Hawaii, a fair collection of the sweet or "honey" sorghums has been secured. The seeds now desired are of wild sorghums with plenty of vegetative vigour and good tillering. The seeds if from outside India will need to be kindly fumigated and certified as above before despatch. All such help will be gratefully acknowledged in future publications.

T. S. VENKATRAMAN,
*Government Sugarcane Expert,*
*Lawley Road Post (Viâ Coimbatore, South India).*

# List of Agricultural Publications in India from 1st February to 31st July 1931.

| No. | Title. | Author. | Where published. |
|---|---|---|---|
| | **GENERAL AGRICULTURE.** | | |
| 1 | *Agriculture and Live Stock in India*, Vol. 1. Parts II and III. Annual Subscription Rs. 6 or 9s. 9d. | Issued under the authority of the Imperial Council of Agricultural Research. | Government of India Central Publication Branch, Calcutta. |
| 2 | *The Indian Journal of Agricultural Science*, Vol. I, Parts I, II and III. Annual subscription, Rs. 10 or 16s. 6d. | Ditto . | Ditto. |
| 3 | *The Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Rs. 3. | E. Narasinha Ayengar (Editor). | Bangalore Press, Bangalore. |
| 4 | *The Madras Agricultural Journal* (Monthly). Annual subscription, Rs. 4. | B. Viswanath and others (Editors). | The Electric Printing Works, Coimbatore. |
| 5 | *The Planters' Chronicle* (Weekly). Price, As. 8 per copy. | F. E. James (Editor) . | Diocesan Press, Post box 455, Madras. |
| 6 | *Rural India* (Monthly). Annual subscription, Rs. 3. | A. Swaminatha Iyer (Editor). | Magazine Press, Chingleput, South India. |
| 7 | *Journal of the Trichinopoly District Agricultural Association* (Quarterly). Annual subscription, Rs. 1-8 for non-members, free for members. | Issued by the Trichinopoly District Agricultural Association. | District Agricultural Association, Trichinopoly, South India. |
| 8 | *Poona Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 2-8. | V. G. Deshpande and S. M. Rao (Editors). | Aryabushan Press, Poona city. |
| 9 | *Quarterly Journal of the Indian Tea Association.* Price, As. 6 per copy. | Scientific Department of the Indian Tea Association, Calcutta. | Catholic Orphan Press, Calcutta. |
| 10 | *The Allahabad Farmer* (Quarterly). Annual subscription, Rs. 2. | W. B. Hayes (Editor) . | The Mission Press, Allahabad. |
| 11 | Seasonal Notes of the Department of Agriculture, Punjab (Quarterly). Price, As. 4 per copy. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 12 | *The Nagpur Agricultural College Magazine* (Quarterly). Annual subscription, Rs. 3. | S. M. Ali and N. B. Chinchalkar (Editors). | Udyam Desha Sevak Press Nagpur. |
| 13 | Proceedings of the Board of Agriculture in India, held at Pusa on the 9th December 1929 and following days (with Appendices). Price, Rs. 3-10 or 6s. 3d. | Issued by the Imperial Council of Agricultural Research. | Government of India Central Publication Branch, Calcutta. |

| No. | Title. | Author. | Where published. |
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| | **GENERAL AGRICULTURE**—*contd.* | | |
| 14 | Scientific Reports of the Imperial Institute of Agricultural Research, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert and Secretary, Sugar Bureau) for 1929-30. Price, Rs. 3-8 or 6s. | Issued by the Director, Imperial Institute of Agricultural Research, Pusa. | Government of India Central Publication Branch, Calcutta. |
| 15 | Villager's calendar for 1931-32 (Kanarese, Telugu and Tamil). | Issued by the Department of Agriculture, Madras. | Government Press, Madras. |
| 16 | Digest of the Operations of the Department of Agriculture, Madras, for the quarter ending 30th December 1930. Madras Department of Agriculture Digest No. 90. (English, Tamil, Telugu, Malayalam and Kanarese.) | D. Ananda Rao, B. Sc. | Ditto. |
| 17 | Digest of the operations of the Department of Agriculture, Madras, for the quarter ending 31st March 1931. Madras Department of Agriculture Digest No. 91. (English, Tamil, Telugu, Malayalam and Kanarese). | Ditto . . . | Ditto. |
| 18 | Results of Demonstration of Agricultural Improvements in the Madras Circle carried out during 1924-27. Madras Department of Agriculture Bulletin No. 97. (Tamil). | Ditto . . . | Ditto. |
| 19 | Notes on the result of chemical, entomological and mycological experiments conducted at the Betelvine Research Station, Vellalur, during 1925-30. Madras Department of Agriculture Pamphlet No. 3. (English, Tamil, Telugu, Malayalam and Kanarese). | B. Viswanath, F.I.C., F.C.S., Y. Ramachandra Rao, M.A., F.E.S. and S. Sundararama Ayyar, M A. | Ditto. |
| 20 | Plough early. Madras Department of Agriculture Broad hints for every day use No. III. (English, Tamil, Telugu, Malayalam and Kanarese). | D. Ananda Rao, B. Sc. . | Ditto. |
| 21 | Plough efficiently. Madras Department of Agriculture Broad hints for every day use No. IV. (English, Tamil, Telugu and Kanarese). | Ditto . . . | Ditto. |

| No. | Title. | Author. | Where published. |
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| | **GENERAL AGRICULTURE—*contd.*** | | |
| 22 | Sow good seed. Madras Department of Agriculture Broad hints for every day use No. V. (English, Tamil, Telugu and Kanarese.) | G. R. Hilson . . | Government Press, Madras. |
| 23 | Beware of weeds. Madras Department of Agriculture Broad hints for every day use No. VI. (English, Telegu, Malayalam and Kanarese.) | Ditto . . . | Ditto. |
| 24 | Note on pure paddy seed, I circle. Madras Department of Agriculture Notes No. 2. (English and Telugu.) | A. C. Edmonds, B.A. . | Ditto. |
| 25 | Note on pure paddy seed, VI circle. Madras Department of Agriculture Notes No. 3. (English and Tamil.) | B. Ramiah . . . | Ditto. |
| 26 | Some suggestions to the ryots of the IV circle to obtain and keep paddy seed pure. Madras Department of Agriculture Notes No. 4. (English, Tamil and Telugu.) | M. Govinda Kidavu, Dip. Agri. | Ditto. |
| 27 | Care and management of cattle manure in South India. Madras Department of Agriculture Leaflet No. 24. (English, Tamil, Telugu, Malayalam and Kanarese.) | V. Muthuswami Ayyar . | Ditto. |
| 28 | Green manuring. Madras Department of Agriculture Leaflet No. 25. (English, Tamil, Telugu, Malayalam and Kanarese.) | B. Ramiah . . . | Ditto. |
| 29 | Revised note on tapioca. Madras Department of Agriculture Leaflet No. 26. (English, Tamil, Telugu, Malayalam and Kanarese.) | K. Unnikrishna Menon . | Ditto. |
| 30 | Telugu songs on improved method of paddy cultivation. Madras Department of Agriculture Leaflet No. 27. (Telugu.) | D. Balakrishnamurthi . | Ditto, |
| 31 | Weeds—Weeds—Weeds. Madras Department of Agriculture Leaflet No. 28. (English, Tamil, Telugu, Kanarese and Malayalam.) | D. T. Chadwick . . | Ditto. |
| 32 | The Sindhewahe furnace for Jaggery manufacture. Madras Department of Agriculture Leaflet No. 29. (English, Tamil, Telugu, Kanarese and Malayalam.) | C. Narayana Ayyar . | Ditto. |

| No. | Title. | Author. | Where published. |
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| | **GENERAL AGRICULTURE**—*contd.* | | |
| 33 | Pure cotton. Madras Department of Agriculture Leaflet No. 33. (English and Tamil.) | B. Ramiah . . . | Government Press, Madras. |
| 34 | Study in intensive farming near Poona under canal irrigation. Bombay Department of Agriculture Bulletin No. 164 of 1930 Price, As. 4. | B. S. Patel and H. M. Desai. | Government Central Press, Bombay. |
| 35 | Frost of January 1929 and its damage to crops of the Bombay Presidency, Bombay Department of Agriculture Bulletin No. 165 of 1930. Price, Annas 6. | K. V. Joshi . . . | Ditto. |
| 36 | Annual Report of the Department of Agriculture in the Bombay Presidency for the year 1929-30. Price, Annas 13. | Issued by the Department of Agriculture, Bombay. | Ditto. |
| 37 | Season and Crop Report of the Bombay Presidency for the year 1929-30. Price, Annas 5. | Ditto . . | Ditto. |
| 38 | Monthly and Annual Rainfall Table in the Province of Bengal for 1930. | Issued by the Department of Agriculture, Bengal | Bengal Secretariat Book Depôt, Calcutta. |
| 39 | Season and Crop Report of Bengal for 1930-31. | Ditto . . | Ditto |
| 40 | Dudsar paddy (English and Bengali). Leaflet No 3 of 1931 of the Department of Agriculture, Bengal. | Ditto . . | Ditto. |
| 41 | Notes on improved method of Agriculture for Bengal with improved implements specially designed and locally constructed to suit the soils, the cattle and the pocket of the Bengalee cultivator (English and Bengali). Leaflet No. 4 of 1931 of the Department of Agriculture, Bengal. | Ditto . . | Ditto. |
| 42 | Agricultural population in some Eastern Districts of U. P.,— | | |
| | 1 Gorakhpur . . . . | Jai Krishna Mathur, M.A. | Superintendent, Govt., Press, Allahabad. |
| | 2. Jaunpur . . . . . | B. N. Misra, M. A., . | Ditto. |
| 43 | Bulletin No. 50 of the Department of Agriculture, U. P. | Ditto . . | Ditto |

| No. | Title. | Author. | Where published. |
|---|---|---|---|
| | **GENERAL AGRICULTURE**—*contd.* | | |
| 44 | Organization of Wheat Trade in N. W. Region, U P. Bulletin No. 51 of the Department of Agriculture, U. P. | Tiryngi Prasad, M. A. . | Superintendent, Govt. Press, Allahabad. |
| 45 | Economic Survey of a Village in Cawnpore. Bulletin No. 52 of the Department of Agriculture, U. P. | Ram Misra . . . | Ditto. |
| 46 | Experiments in Electric Farming. Bulletin No. 53 of the Department of Agriculture, U P. | Dr. S. S. Nehru . . | Ditto. |
| 47 | Dynamometer Tests and Efficiency of Some Improved Ploughs. Bulletin No. 54 of the Department of Agriculture, U. P. | C Maya Das . . | Ditto. |
| 48 | A brochure on School Gardens. Bulletin No. 55 of the Department of Agriculture, U P. (Revised edition of Bulletin No. 34.) | Issued by the Department of Agriculture, U. P. | Ditto. |
| 49 | Report on Cotton Purchase Operations, 1929-30 and 1930 31 Bulletin No. 57 of the Department of Agriculture, U P. | Ditto . . | Ditto. |
| 50 | The Farm Tractor in India Bulletin No. 56 of the Department of Agriculture, U. P. | C. Maya Das . . | Ditto. |
| 51 | C. 402. A new variety of Long Staple Cotton in U. P. Bulletin No. 58 of the Department of Agriculture, U. P. | Ram Prasad . . | Ditto |
| 52 | Studies in Agricultural Improvement . | C. Maya Das . . | Ditto. |
| 53 | Annual Report of the Department of Agriculture, Punjab, for the year ending June 1930, Part I. Price Re. 1-6 or 2*s.* 2*d.* per copy. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 54 | A copy of Tables of Agricultural Statistics of the Punjab for the year 1929-30. | Ditto . . | Ditto. |
| 55 | Potato crop and its improvement in the Punjab. Price, Annas 6. | D. Milne, C.I.E., B.Sc., I.A.S., and K. S. Ch. Ali Mohammad, B.Sc. (Agri.), L. Ag. | Ditto. |
| 56 | Experiments at the Agricultural Farm, Lyallpur. Price, Rs. 2. | D. P. Johnston, A.R.C. Sc.I., N.D.A. | Ditto. |

| No. | Title. | Author. | Where published. |
|---|---|---|---|
| | **GENERAL AGRICULTURE**—*contd.* | | |
| 57 | How to succeed with berseem. Punjab Department of Agriculture Leaflet No. 90. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 58 | Reclamation of Kalar Soils. Punjab Department of Agriculture Leaflet No. 91. | Ditto . . | Ditto. |
| 59 | Methods of Legume inoculation. Punjab Department of Agriculture Leaflet No. 92. | Ditto . . | Ditto. |
| 60 | Enquiries regarding Indian oilseed crops (Urdu). Price, Annas 5 per copy. | K. S. Ch. Ali Mohammad, B.Sc. (Agri.), L. Ag. | Ditto. |
| 61 | Season and Crop Report of the Department of Agriculture, Bihar and Orissa, for 1930-31. | Issued by the Department of Agriculture, Bihar and Orissa. | Government Printing, Bihar and Orissa, Gulzarbagh. |
| 62 | Annual Report on Experimental Farms in Bihar and Orissa for 1929-30. | Ditto . . | Ditto. |
| 63 | Sugarcane Crushing Mills—its adjustment and care. Bihar and Orissa Department of Agriculture Leaflet No. 1 of 1931. (English and Oriya.) | Ditto . . | Ditto. |
| 64 | Water lifts in Bihar and Orissa. Bihar and Orissa Department of Agriculture Leaflet No. 2 of 1931. (English.) | Ditto . . | Ditto. |
| 65 | Report on Demonstration work carried out in the Western Circle, Central Provinces, together with the Reports on the Seed and Demonstration and Cattle Breeding Farms of that Circle for the year ending 31st March 1930. Vol. I. Price, Re. 1. | Issued by the Department of Agriculture, Central Provinces. | Government Printing, Central Provinces, Nagpur. |
| 66 | Report on Demonstration work carried out in the Northern Circle, Central Provinces, together with the Reports on the Seed and Demonstration Farms for the year ending 31st March 1930. Price, Re. 1. | Ditto . . | Ditto. |
| 67 | Report on Demonstration work carried out in the Plateau sub-circle, Central Provinces, together with the Reports on the Seed and Demonstration Farms of that Circle for the year ending 31st March 1930. Price, Re. 1. | Ditto . . | Ditto. |

| No. | Title. | Author. | Where published. |
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| | **GENERAL AGRICULTURE**—*contd.* | | |
| 68 | Report on Demonstration work carried out in the Southern Circle, Central Provinces, together with the Reports on the Seed and Demonstration Farms, Waraseoni and Sindewahi, and the Cattle Breeding Farm, Sindewahi, for the year ending 31st March 1930. Price, Re. 1. | Issued by the Department of Agriculture, Central Provinces. | Government Printing, Central Provinces, Nagpur. |
| 69 | Report on Demonstration work carried out in the Eastern Circle, Central Provinces, together with Reports on the Seed and Demonstration Farms at Chandkhuri, Bilaspur and Drug, with that of Cattle Breeding Stations attached thereto for the year ending 31st March 1930. Price, Rs. 2-10. | Ditto . . | Ditto. |
| 70 | Annual Reports of Experimental Farms of the Southern and Eastern Circles, Tharsa and Raipur, Central Provinces, for the year ending 31st March 1930. Price, Re. 1. | Ditto . . | Ditto. |
| 71 | Annual Reports of Experimental Farms, Akola, and the Experimental Farm attached to the Agricultural College, Nagpur, Central Provinces, for the year ending 31st March 1930. Price, Re. 1. | Ditto . . | Ditto. |
| 72 | Report on the (1) Agricultural College, Nagpur, (2) Chemical, Botanical, Mycological and Entomological Research, (3) Agricultural Engineer's Section, (4) Maharajbagh Menagerie together with the external work of the Veterinary Inspector attached to the Agicultural College, Nagpur, Central Provinces, for the year ending 31st March 1930. Price, Re. 1. | Ditto . . | Ditto. |
| 73 | Annual Reports of Experimental Farms of the Northern and Plateau Circles, Powarkhera, Adhartal, Chhindwara, Central Provinces, with that of Cattle Breeding Stations attached thereto for the year ending 31st March 1930. Price, Re. 1. | Ditto . . | Ditto. |
| 74 | How to increase yield in paddy. Leaflet No. 2 of 1931 of the Department of Agriculture, Assam. (English, Assamese and Bengali.) | Issued by the Department of Agiculture, Assam. | Government Press, Shillong. |

| No. | Title. | Author. | Where published. |
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| | **GENERAL AGRICULTURE—*concld.*** | | |
| 75 | Guava Jelly. Leaflet No. 3 of 1931 of the Department of Agriculture, Assam. | Issued by the Department of Agricultnre, Assam. | Government Press, Shillong. |
| 76 | The Annual Report of the Civil Veterinary Department, Assam, for 1930-31. | Ditto . . . | Ditto. |
| | **BOTANY.** | | |
| 77 | Effect of some Meteorological Conditions on the Growth of Punjab-American Cotton. Memoirs of the Department of Agiculture in India, Botanical Series, Vol. XVII, No. 6. Price, As. 7 or 9*d*. | Trevor Trought, M.A. . | Government of India Central Publication Branch, Calcutta. |
| 78 | The Inheritance of Characters in Rice, Part IV. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 8. Price, Re. 1-6 or 2*s*. 3*d*. | K. Ramiah, L. Ag., M.Sc., Dip. Agri. (Cantab.), S. Jobitharaj and S. Dharmalingamudaliar. | Ditto. |
| 79 | A Leafspot Disease of *Andropogon Sorghum* caused by *Cercospora Sorghi* E. & E. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XVIII, No. 9. Price, As. 10 or 1*s*. | T. S. Ramkrishnan, M.A. | Ditto. |
| 80 | Studies in *Cajanus indicus*. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XIX, No. 1. Price, Re. 1-14 or 3*s*. 3*d*. | D. N. Mahta, B.A. (Cantab.), F.L.S., and B. B. Dave, L.Ag. | Ditto. |
| 81 | Studies in Indian Pulses, (2) Some varieties of Indian Gram (*Cicer arietinum* Linn). Memoirs of the Department of Agriculture in India, Botanical Series, Vol. XIX, No. 2. Price, Re. 1-12 or 3*s*. | F. J. F. Shaw, D.Sc., A.R.C.S., F.L.S., and Khan Sahib Abdur Rahman Khan. | Ditto. |
| | **MYCOLOGY.** | | |
| 82 | Red rot disease of sugarcane. Madras Department of Agriculture, Leaflet No. 30. (English, Tamil, Telugu, Kanarese and Malayalam.) | S. Sundararama Ayyar, M.A. | Government Press, Madras. |
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| 84 | Coconut Stem bleeding disease. Madras Department of Agriculture, Leaflet No. 32. | Ditto . | Ditto. |

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| 85 | Sprayers and Spraying. Madras Department of Agriculture, Leaflet No. 34. (English, Tamil, Telugu, Malayalam and Kanarese.) | S. Sundararama Ayyar, M.A. | Government Press, Madras. |
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| | **ENTOMOLOGY.** | | |
| 90 | A contribution towards our knowledge of the Aleyrodidae (White Flies) of India. A New Coccid injurious to Fruit Trees in Baluchistan. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. XII, Nos. 1 and 2. Price, Rs. 3-2 or *5s. 6d.* | Karam Singh, M.Sc., and F. Laing. | Government of India Central Publication Branch, Calcutta. |
| 91 | List of Publications on Indian Entomology, 1929. Pusa Bulletin No. 207. Price, As. 10 or 1*s.* | Compiled by the Imperial Entomologist, Pusa. | Ditto. |
| 92 | Army Worm of paddy. Madras Department of Agriculture Leaflet No. 14. (English, Tamil, Telugu, Kanarese and Malayalam.) | Y. Ramachandra Rao, M.A., F.E.S. | Government Press, Madras. |
| 93 | Prickly pear cochineal. Madras Department of Agriculture, Leaflet No. 35. (English, Tamil, Telugu, Malayalam and Kanarese.) | T. V. Ramakrishna Ayyar, B.A., Ph.D., F.Z.S. | Ditto. |
| 94 | San Jose Scale (*Comstockaspis perniciosa*, Comst.) and its control. Punjab Department of Agriculture, Leaflet No. 88. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |

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| | **ENTOMOLOGY**—*contd.* | | |
| 95 | The Sugarcane Leaf-hopper (*Pyrilla* spp.) and its control. Punjab Department of Agriculture, Leaflet No. 89. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| 96 | Common Insecticides and their Control. Leaflet of the Department of Agriculture, Central Provinces. (Hindi and Marathi.) | Issued by the Department of Agriculture, Central Provinces. | Government Printing, C. P., Nagpur. |
| 97 | Instructions for control of Locusts. Leaflet of the Department of Agriculture, Central Provinces. (Hindi and Marathi). | Ditto | Ditto. |
| | **ANIMAL HUSBANDRY AND DAIRYING.** | | |
| 98 | *Ragi* Silage in Coimbatore District. Madras Department of Agriculture, Notes No. 5. (English and Tamil.) | K. Gopala Krishna Raju. | Government Press, Madras. |
| 99 | Sheep Breeding. Punjab Veterinary Department Leaflet No. 4. | Issued by the Director, Veterinary Services, Punjab. | Government Printing, Punjab, Lahore. |
| 100 | Report on the Cattle Breeding Operations in the Central Provinces and Berar for the year ending 31st March 1930. Price, Re. 1. | Issued by the Department of Agriculture, Central Provinces. | Government Printing, Central Provinces, Nagpur. |
| 101 | Suggestions for improving the Health of cattle in Assam. Leaflet No. 1 of 1931 of the Department of Agriculture, Assam. | Issued by the Department of Agriculture, Assam. | Government Press, Shillong. |
| 102 | Ranikhet Disease of Fowls. Punjab Department of Agriculture Leaflet No. 93. | Issued by the Department of Agriculture, Punjab. | Government Printing, Punjab, Lahore. |
| | **VETERINARY.** | | |
| 103 | The *Indian Journal of Veterinary Science and Animal Husbandry*, Vol. I, Parts I and II. Annual subscription, Rs. 5 or 8*s*. 3*d*. | Issued under the authority of the Imperial Council of Agricultural Research. | Government of India Central Publication Branch, Calcutta. |
| 104 | The *Indian Veterinary Journal* (The Journal of the All-India Veterinary Association) (Quarterly). Annual subscription, Rs. 4 or 5*s*. 4*d*. for members and students, Rs. 8 or 10*s*. for others. | P. Srinivasa Rao, G. M. V. C. (Editor). | Peoples Printing and Publishing House, Ltd., Triplicane, Madras. |

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| | **VETERINARY**—*contd.* | | |
| 105 | Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March 1930. Price, Re. 1-6 or 2*s.* 3*d.* | Issued by the Director, Imperial Institute of Veterinary Research, Muktesar, Kumaun. | Government of India Central Publication Branch, Calcutta. |
| 106 | Care and management of cattle in Bengal. (Translation in Bengali of the English pamphlet.) | Issued by the Department of Agriculture, Bengal. | Bengal Government Press, Calcutta. |
| 107 | On Rinderpest. Punjab Veterinary Department Leaflet No. 1. | Issued by the Director, Veterinary Services, Punjab. | Government Printing, Punjab, Lahore. |
| 108 | On Haemorrhagic Septicaemia. Punjab Veterinary Department Leaflet No. 2. | Ditto . . | Ditto. |
| 109 | On Foot and Mouth Disease, Punjab Veterinary Department Leaflet No. 3. | Ditto . . | Ditto. |
| 110 | Instruction for the inoculation of animals with serum virus or vaccine and notes on the care, handling and sterilization of hypodermic syringes. Burma Veterinary Department Pamphlet No. 1 of 1930. (Burmese.) | Issued by the Director of Veterinary Services, Burma. | Government Press, Rangoon. |
| 111 | Parasitic Worms of Domestic Animals. Burma Veterinary Department Bulletin No. 7 of 1928. (Burmese.) | Ditto . . | Ditto. |

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# Index to Volume I.

## A

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## V

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## Z

## Errata to Volume I.

Page 250, second column, line 3, *for* ' Solkart ' *read* ' Volkart'.
Page 313, line 13, *omit* — after Actual live weight.
Page 313, lines 17 and 22, *for* ·04 *read* ·004.
Page 313, lines 18 and 23, *for* ·036 *read* ·0036.
Page 313, lines 21 and 23, *for* ' (1000-actual L. W.) ' *read* ' (actual L. W.-1000)'.
Page 327, line 26, *for* ' (927) ' *read* ' (1927) '.
Page 368, line 10 from bottom, *for* ' Octori ' *read* ' Octroi '.
Page 372, line 19, *for* ' paymeut ' *read* ' payment '.
Page 417, line 16, *for* $F_1$ $F_2$ *read* $F_1$, $F_2$.
Page 419, line 7 from bottom, *for* 0·92......02 *read* 0·92$\pm$·02.
Page 427, line 18 from bottom, *add* " after sick.
Page 430, first line, *for* ' pounds ' *read* ' pound '.
Page 503, line 10, *for* [ 1930, 2 ] *read* [ 1913, 2 ].
Page 558, line 4 from the bottom, *for* ' sping ' *read* ' spring '.
Page 560, line 9 from bottom, *for* ' corps ' *read* ' crops '.
Page 568, line 1, *for* ' Denial ' *read* ' Daniel '.
Page 574, line 6 from bottom *for* ' thatt he ' *read* ' that the '.
Page 576, line 8, *for* ' mure ' *read* ' more '.
Page 615, line 12, *for* ' figues ' *read* ' figures '.
Page 633, line 27, *for* ' therefore *re*,' *read* ' therefore, *re* '.
Page 636, heading of the last column of Table, *for* ' loge ' *read* ' $\log_e$ '.
Page 644, line 13 *for* ' (page 644) ' *read* ' (page 645) '.
Page 646, line 7 from bottom *for* ' (pages 650-653) ' *read* ' (pages 651-654) '.
Page 652, Table III, column 3, facing February 5 there ought to be ' 6 '.
Page 655, Table IV, column 3, row 2, *for* ' 9·5 ' *read* ' 90·5 '.
Page 655, Table IV, column 7, row 3, *for* ' 1-45 ' *read* ' 1·45 '.
Page 673, footnote, *for* ' 22nd 28th ' *read* ' 22nd-28th '.
Page 694, line 20, *for* ' osthreussen ' *read* ' ostpreussen '.

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